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On the Adjustment of the Global Economy

Carlos de Resende, Claudia Godbout, René Lalonde, Éric Morin and Nikita Perevalov, International Economic Analysis Department

- Consistent with the message from the November 2011 G-20 summit in Cannes, this article shows that the implementation of a set of policies could lead to balanced global economic growth and an orderly resolution of global imbalances over the medium term.
- Such an outcome would require fiscal consolidation in the United States and Europe, flexible exchange rates and structural policies to stimulate domestic demand in the emerging-market economies of Asia, and structural reforms in Europe and Japan.
- We also present possible scenarios in which a delay in implementing these measures leads to a significantly weaker global economy and undermines the correction of global imbalances.
- The scenarios also suggest that aggressive fiscal consolidation in advanced economies that is not accompanied by flexible exchange rates and structural reforms in the emerging-market economies of Asia, as well as by growth-enhancing reforms in Europe and Japan, could lead to even weaker growth in global output and near-term deflationary pressures.

Current account deficits reflect low domestic savings relative to investment or, alternatively, excessive aggregate spending relative to domestic income. The opposite is true for current account surpluses: domestic savings are high relative to investment, and aggregate spending is low relative to domestic income. When surplus countries use their savings to finance more-profitable investment opportunities in deficit countries, current account imbalances can benefit the global economy. In normal circumstances, these imbalances would tend to be limited, since deficit economies cannot finance large current account imbalances indefinitely. Imbalances also tend to correct themselves when market-based adjustment mechanisms—based on movements in relative prices (i.e., real exchange rates) and/or relative income—function without frictions.

Over the past decade, however, the world economy has been experiencing much larger and more-persistent current account imbalances compared with the historical norm. For the most part, these global imbalances have taken the form of sizable and persistent deficits in the United States, mirrored by surpluses in other countries, particularly in Asia and in major oil-exporting countries. Although cyclical factors have led to a temporary narrowing of global imbalances, they remain significant and, without the set of policy measures described in this article, could increase as the global

- *Over the past decade, the world economy has been experiencing much larger and more-persistent current account imbalances*

recovery takes place. These global imbalances are a major source of concern for two main reasons. First, it is possible that the flows from high-savings (surplus) economies are being used to finance non-productive investment, unsustainable government deficits or excessive credit-fuelled consumption (e.g., the run-up in housing and consumption observed in the United States before the 2007–09 financial crisis). Second, frictions (e.g., capital controls and inflexible exchange rates) and structural factors (e.g., relatively underdeveloped financial markets) in the surplus economies may be forestalling the necessary adjustment from taking place.

For example, a real depreciation of the exchange rates in deficit countries, which facilitates switching expenditures from foreign goods to domestic goods in those countries, may not occur because surplus countries prevent their exchange rates from adjusting freely. More generally, the prevalence of interventionist policies in surplus countries, such as capital controls, reserve accumulation and trade barriers, may prevent an orderly correction of global imbalances. As Little and Lafrance (2006) state, "the longer these imbalances persist, the greater the risk of a sharper reversal that could destabilize the world economy and undermine growth." Persistent global imbalances may also provoke abrupt swings in exchange rates and sudden corrections in capital flows, disrupting global financial markets (Beaton et al. 2010). Furthermore, these imbalances may lead to an accumulation of financial risks and instability, similar to the environment that preceded the global financial crisis that started in 2007 (Bini Smaghi 2011; Obstfeld and Rogoff 2009; Santor and Schembri 2011).

The longer these imbalances persist, the greater the risk of a sharper reversal that could destabilize the world economy and undermine growth

In this article, we use the Bank of Canada's GMUSE and BoC-GEM-Fin models[1] to present three possible scenarios for the global economy. We first show a "baseline" scenario that encompasses policies consistent with those outlined in the communiqué from the G-20 Cannes Summit in November 2011, in which there is sustained global economic growth and the resolution of global imbalances over the medium term. Note that the baseline scenario should not be considered the Bank of Canada's official projection; rather, it is a possible scenario in which a set of conditions and policies is put in place to gradually resolve global current account imbalances. Furthermore, we conduct our simulations using data up to June 2011.[2] Alternatively, we consider a scenario where the implementation of all of the suggested policy measures is delayed until the end of 2015, leading to global imbalances persisting for a longer time and global economic growth being substantially reduced over the medium term. Finally, a second alternative scenario illustrates that more-aggressive fiscal consolidation in advanced economies, without policies to stimulate domestic demand in emerging-market economies or growth-enhancing structural reforms worldwide, could generate significant near-term deflationary pressures and lead to even weaker growth in global demand.

1. GMUSE has been the main projection model used in the International Economic Analysis Department of the Bank of Canada since 2011. It is a macroeconometric model comprising blocks for the United States, the euro area, Japan, China and the rest of the world. The Bank of Canada's Global Economy Model with Financial Frictions (BoC-GEM-Fin) is a multi-sector dynamic stochastic general-equilibrium model encompassing the world economy and featuring a detailed financial sector. This model is used for policy analyses at the Bank (de Resende and Lalonde 2011).

2. The inclusion of recent data would not change the main conclusions of this article.

The Baseline Scenario: Adopting the Cannes Policy Reforms

We developed a baseline scenario to examine the potential implications for global economic growth if the types of policies outlined at the G-20 Cannes Summit were implemented.[3] The baseline scenario assumes the following:

(i) A credible fiscal consolidation is undertaken in the United States and Europe, where primary deficits[4] are gradually reduced and the ratio of debt to gross domestic product (GDP) is stabilized in the United States and on a declining path in Europe by 2015.[5]

(ii) A rotation of demand within the emerging-market economies of Asia away from exports and toward domestic spending is induced by (a) structural reforms stimulating domestic demand in these regions, and (b) adjustments in their real effective exchange rates.

(iii) Structural reforms are implemented in Europe and Japan that gradually increase the level of potential GDP by 2 per cent by the end of 2015.

Fiscal consolidation in the United States and Europe

Chart 1 shows the recent evolution of the ratios of the total U.S. fiscal deficit and federal debt to GDP, as well as their projected paths.[6] Note that the primary surpluses in the early 2000s and again in late 2007 turned into a growing primary deficit that peaked at 7.8 per cent of GDP in mid-2009, as government revenues declined and welfare spending increased, and the fiscal stimulus was implemented in response to the Great Recession. Meanwhile, U.S. Treasury debt held by the public relative to GDP reached almost 65 per cent in the second quarter of 2011, compared with its pre-crisis level of approximately 35 per cent.

The fiscal consolidation measures included in the baseline scenario are consistent with the communiqués from the G-20 summits in Toronto in 2010 and Cannes in 2011. In the near term, we assume that additional fiscal stimulus is supplied to support economic growth. Beyond that, the primary deficit for the consolidated government sector falls from about 6 per cent in mid-2011 and becomes a surplus in 2014 (Chart 1). This reduction in the primary deficit is consistent with the total deficit being cut in half by the end of 2013, as outlined in the Toronto Summit agreement. We assume that fiscal consolidation will be implemented gradually over the medium term, resulting in the U.S. federal debt held by the public stabilizing at approximately 80 per cent of GDP by 2015. The fiscal consolidation in the United States helps to reduce the U.S. current account deficit, since a lower government primary deficit (in this case a surplus) increases total domestic savings, given the same level of investment.

3 See "Cannes Summit Final Declaration – Building Our Common Future: Renewed Collective Action for the Benefit of All," G-20, November 2011. Available at <http://www.g20.gc.ca/g8-g20/g20/eng/publications/publications-news-releases/cannes-summit-final-declaration-1563.html>.

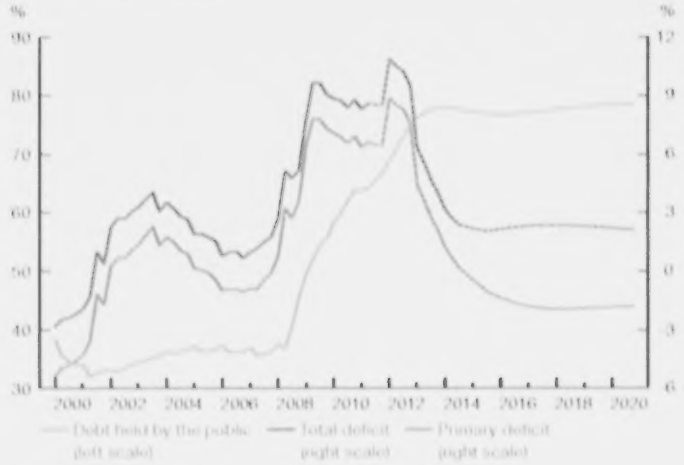
4 The primary deficit (surplus) is defined as the total government deficit (surplus), excluding net interest payments, namely, interest expenditures minus interest revenue. It measures the ability of the government to pay for its current spending out of the revenue it generates.

5 The baseline scenario also incorporates fiscal consolidation in Japan but, given the stimulus implemented by the Japanese government in response to the earthquake and tsunami in March 2011, the expected consolidation over the 2012–15 period is not sufficient to stabilize the ratio of debt to GDP over the next five years.

6 Based on recent macroeconomic developments, the current path of the U.S. fiscal deficit would likely be higher than the one highlighted in the baseline scenario.

Chart 1: **Total U.S. government deficit and federal debt held by the public**

As a percentage of GDP



Note: Dotted lines indicate projections.
Sources: GMUSE and BoC-GEM-Fin simulations. Last observation: June 2011

In the European Union, gross government debt increased from less than 60 per cent of GDP in 2007 to more than 80 per cent of GDP in 2011. In the baseline scenario, we assume that announced fiscal-consolidation measures are put in place. Although there are large variations across countries, this fiscal consolidation is consistent with a declining ratio of debt to GDP by 2015 for the region as a whole.

Rotation of demand in China and the other emerging-market economies of Asia

China and the other emerging-market economies of Asia have been experiencing persistently large current account surpluses, reflecting notably both structurally high savings rates and export-driven policies to support economic growth, such as management of the exchange rate and accumulation of reserves.[7] As a result of these policies, domestic demand in the emerging-market economies of Asia has been relatively low.[8]

In the baseline scenario, we assume that a rotation of demand in China and the other emerging-market economies of Asia is gradual, reflecting two main policy measures taking place over the next 10 years. First, structural policies will reduce the propensity to oversave and stimulate domestic demand in both regions, boosting it by around 4.5 per cent of GDP by 2020.[9] Second, we assume less government intervention in foreign exchange markets, leading to a gradual but significant appreciation of their real exchange rates by the end of 2020. GMUSE endogenously determines that a permanent appreciation in the Chinese real effective exchange rate of 20 per cent relative

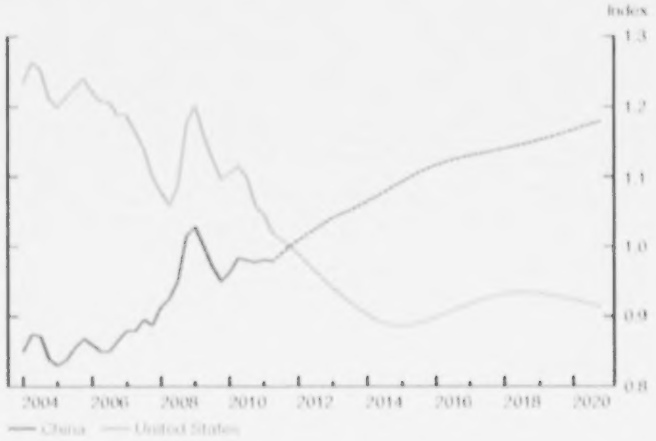
7 While the current account surpluses have decreased since the beginning of the global financial crisis, this adjustment reflects mainly cyclical factors.

8 For example, in China, private consumption spending represents only 30 per cent of total aggregate demand.

9 GMUSE does not specify which policies are implemented; it indicates only their size and timing. The figures reported above are conditional on the starting values for domestic demand and current account balances relative to their respective paths for balanced growth. The underlying policies are in line with China's twelfth five-year plan, which aims to increase the share of the service sector in GDP by 4 percentage points by implementing policies ranging from deepening financial markets and developing the domestic banking sector to improving social safety nets and reforming the tax system.

Chart 2: **Baseline scenario—real effective exchange rates in China and the United States**

Index: 2011Q4 = 1



Note: Dotted lines indicate projections.
Sources: GMUSE and Bank of Canada GEM-Fin simulations

Last observation: June 2011

to its level in the second quarter of 2011 is consistent with the stabilization of the Chinese current account (as a percentage of GDP) over the long run.[10] Consistent with the appreciation of the renminbi, the model also projects a 10 per cent depreciation in the real effective exchange rate of the U.S. dollar by the end of 2020 (Chart 2). These adjustments to exchange rates play an important role in facilitating the rotation of domestic demand away from the regions with current account deficits, such as the United States, toward those with current account surpluses, such as Asia.

Adjustments to exchange rates play an important role in facilitating the rotation of domestic demand away from the regions with current account deficits toward those with current account surpluses

Structural reforms in Europe and Japan

The baseline scenario also assumes the implementation of structural reforms in Europe and Japan designed to create greater flexibility in their labour markets and increase competition in their goods markets. Based on Bouis and Duval (2011), we assume that the productivity gains from these reforms gradually increase the level of potential GDP in Europe and Japan by 4.5 per cent over a five-year horizon. We also assume that the benefits of these reforms will only start to be felt by mid-2013, boosting the potential level of GDP by about 2 per cent by the end of 2015.[11]

Outcomes under the baseline scenario

Chart 3 shows the historical and projected paths for the current account balances, as a share of GDP, in the regions featured in GMUSE.[12] Under the policy measures described above, by 2020, the U.S. current account deficit gradually reaches 1.5 per cent of GDP, while China's current account

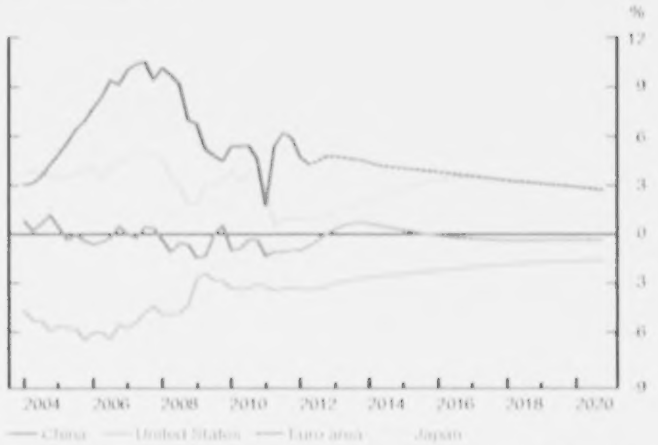
10 The appreciation needed to stabilize the global current account balances depends in part on the assumed desired long-run positions of net foreign assets to GDP.

11 Later in the article, we provide a sensitivity analysis of the effect of this assumption on world economic growth. There is considerable uncertainty around the timing of the benefits of the structural reforms. The timing is clearly conditional on the political situation associated with the current sovereign debt crisis in Europe and on the pace of Japan's recovery from the effects of the 2011 earthquake and tsunami.

12 While GMUSE features the euro area as a separate region, the discussion of fiscal consolidation and structural reforms is concerned with Europe more broadly.

Chart 3: **Current account balances**

As a percentage of GDP[1]



Notes: Dotted lines indicate projections. The euro-area current account is compiled by the European Central Bank on the basis of transactions between euro-area countries and countries outside the euro area.
Sources: GMUSE and BoC–GEM calculations. Last observation: June 2011

surplus shrinks to below 3 per cent. The gradual adjustment of the global imbalances is explained by (i) the timing assumed for both the fiscal consolidation in the United States and Europe and the rotation of demand in China and emerging Asia; and (ii) a delayed response of the current account to movements in real exchange rates.[13]

The baseline scenario is consistent with the G-20 Framework for Strong, Sustainable and Balanced Growth

Chart 3 illustrates that if policy assumptions embedded in the baseline scenario are put in place, global current account imbalances are likely to be reduced over the medium term. Overall, conditional on the implementation of policies addressing internal and external imbalances at the country level, the baseline scenario is consistent with the G-20 Framework for Strong, Sustainable and Balanced Growth, which was adopted at the 2009 G-20 summit in Pittsburgh and reaffirmed at both the 2010 summit in Toronto and, more recently, in Cannes.

We now turn to two plausible alternative scenarios in which the main policy initiatives of the G-20 are either delayed or not implemented.

Alternative Scenario 1: Delayed Fiscal Consolidation and Reforms

In Alternative Scenario 1, we consider the possibility of a delay until the end of 2015 in the fiscal consolidation in advanced economies (specifically, the United States and Europe) and structural reforms supporting growth in domestic demand in China and other emerging-market economies in Asia, including increased flexibility in exchange rates. In addition, we assume that the recommended structural reforms in Japan and Europe do not occur.

13. The outcomes are also conditional on our assumed response of monetary policy, which is to remain close to the effective lower bound in the United States until mid-2014, as well as in Europe and Japan for most of this period. In the two alternative scenarios presented in this article, the policy rates remain constrained in these countries.

Delayed fiscal consolidation in the United States and Europe

In this scenario, the U.S. federal government debt rises by an additional 25 per cent of GDP by the end of 2015. In Europe, the delayed fiscal consolidation causes the ratio of debt to GDP to increase by approximately 10 percentage points over the same period.[14] We assume that the higher and steeper trajectory for government debt in both regions implies a rise in sovereign risk premiums relative to the baseline scenario. Using estimates for the elasticity of interest rates in response to changes in debt from Laubach (2003) as a guide, we assume that premiums increase relative to the baseline by 250 and 275 basis points in the United States and Europe, respectively.[15] We also assume that interest rates for corporations and consumers rise accordingly, reducing private spending and economic activity in those regions.[16]

Beginning at the end of 2012, the increase in interest rates, owing to the rise of the risk premium, starts to dampen investment spending, as well as demand for housing and durable consumption. Delayed fiscal consolidation in countries experiencing current account deficits, such as the United States, reduces the prospects for the correction of global imbalances in the medium term by lowering domestic savings.

Lack of adjustment and a "hard landing" in China and the other emerging-market economies of Asia[17]

In Alternative Scenario 1, we also assume that China and other emerging-market economies in Asia will (i) prevent their real effective exchange rates from adjusting, and (ii) *not* implement structural reforms to stimulate the rotation of total demand away from exports and toward domestic demand until the end of 2015.

Chart 4 compares the path of the Chinese real effective exchange rate in Alternative Scenario 1 with that in the baseline scenario. By the end of 2015, the lack of appreciation in the Chinese currency implies a difference of about 10 per cent relative to the baseline.

In this alternative scenario, we suppose that the delayed adjustment of the exchange rates in China and the other emerging-market economies of Asia, in conjunction with the absence of structural reforms (notably in the financial sector), implies that interest rates are kept exceptionally low. This induces a mispricing of risk, which, combined with the incentive for high precautionary

14 The increase in debt in the United States is comparable with the increase observed from 2008 to 2011, following the financial crisis. In Europe, we assume that countries currently under severe fiscal stress, such as Portugal, Ireland, Italy, Greece and Spain, consolidate their budget. Because of the absence of a fiscal block for Europe in GMUSE, the simulation for the increase in debt in the United States and Europe is done in BoC-GEM-Fin.

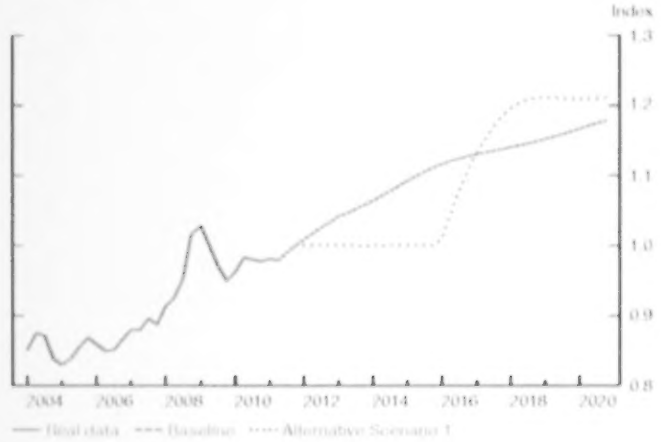
15 There is considerable uncertainty around the assumed elasticity of the risk premium to the ratio of debt to GDP. Laubach (2003) reports that government bond rates increase by 2 to 4 basis points following an increase of 1 percentage point in the ratio of debt to GDP. In our simulation, we double these estimates, in line with Bakkaci and Kumar (2010), Laubach (2011), and Schukoecht, von Hagen and Wolswijk (2010), who find that elasticities could be much larger, given threshold effects and non-linear responses to large levels of indebtedness. Moreover, we assume additional spillovers, amounting to 175 basis points in Europe and 150 basis points in Japan, which are included in the figures discussed above.

16 Without the lower-bound constraint, the policy rate would have fallen by more than 2 per cent within the first two years of the shock to the risk premium in the United States. The lack of additional monetary policy response, beyond the equivalent of a 50-basis-point reduction in interest rates from the quantitative easing (QE) program (see note 24), is crucial for the significant decreases in output observed in this scenario. A larger QE program than the one specified would offset a larger part of the increase in spreads, reducing the negative impact on the economy.

17 Given that GMUSE does not include a separate block for the other emerging-market economies of Asia, in this section, China's exchange rate and domestic demand figures are used to illustrate emerging Asia.

Chart 4: **Alternative Scenario 1—Chinese real effective exchange rate**

Index: 2011Q4 = 1



Note: Dotted lines indicate projections.
Sources: GMUSE and BoC-GEM-Fin simulations

Last observation: June 2011

savings and the relatively underdeveloped capital and credit markets in the region, leads to abnormally high demand and prices for housing and financial assets.

We also assume that the sterilization of reserve accumulation in this region contributes to a buildup of distortions in the domestic banking system (resulting, for example, from low returns on the bonds used for sterilization purposes) that will eventually force authorities to reduce this practice. The reduced sterilization, combined with the buildup of imbalances described above, eventually leads to higher inflationary pressures,[18] resulting in a rapid increase in interest rates, which considerably restrains economic activity. The increase in interest rates and the slowdown in economic activity then results in a significant decline in housing and equity prices, aggravating the decline in domestic demand growth.[19]

In addition, we suppose that the exposure of banks to unprofitable investment projects reduces the availability of credit, further amplifying the effects of the tightening of monetary policy and leading to a banking crisis.[20] We also assume that the misallocation of resources caused by the long exposure to undervalued currency (for example, a disproportionately high investment in the export and real estate sectors and neglect of other sectors that could be more productive) will have permanent negative effects on potential output.[21]

18 We assume that the buildup of imbalances lasts for two years.

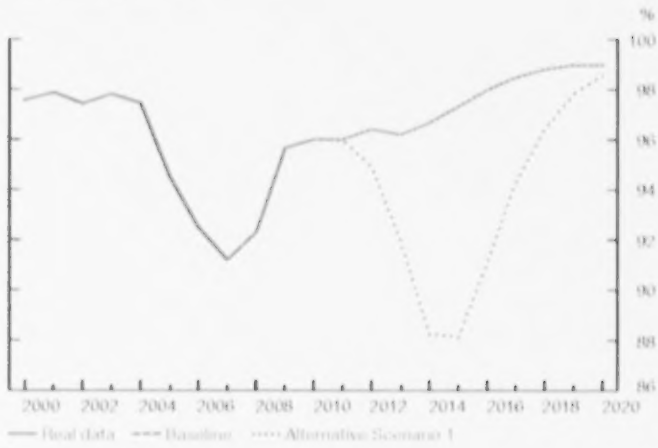
19 We assume that the declines in asset prices are as large as those experienced during the 1997–98 Asian financial crisis (Reinhart and Rogoff 2009). Specifically, we assume that housing prices decline by 40 per cent in China and 30 per cent in the other emerging market economies of Asia, while their stock markets drop by 60 per cent and 50 per cent, respectively, compared with our baseline scenario. The wealth effects of these asset price shocks on domestic demand are consistent with the long-term elasticity found in Peltonen, Sousa and Vansteenkiste (2009) and Carlene (2011).

20 A banking crisis unfolds as lower growth in GDP leads to a large increase in non-performing loans. The exposure of banks to unprofitable investment projects leads to severe deleveraging, which reduces credit availability. The size of the additional shock to domestic demand needed to capture the financial accelerator and bank capital mechanisms is estimated by comparing the effect of shocks in versions of the BoC-GEM-Fin that include and exclude financial frictions.

21 To account for these permanent negative effects, we introduce exogenous reductions in potential output of 4.5 per cent and 3 per cent in China and emerging Asia, respectively. These permanent declines are in line with historical experiences found by Cerra and Saxena (2008).

Chart 5: **Alternative Scenario 1—domestic demand in China**

As a percentage of GDP



Note: Dotted lines indicate projections.
Sources: GMUSE and BoC-GEM-Fin simulations Last observation: 2010

Chart 5 illustrates the possible implications for China's domestic demand in Alternative Scenario 1 compared with the baseline scenario. The share of domestic demand in China's GDP shrinks to less than 90 per cent by mid-2014, compared with about 97 per cent in the baseline scenario. This shock is transmitted internationally through trade, financial and confidence channels.[22]

Outcomes under Alternative Scenario 1

We illustrate that the delay in implementing the policy initiatives described in the baseline scenario could cause imbalances to grow over the 2011–20 period. Both the deficit in the U.S. current account and the surplus in the Chinese current account are larger in Alternative Scenario 1 than in the baseline scenario. The U.S. current account declines to -4.4 per cent of GDP by 2015, while the Chinese current account increases to above 12 per cent (Chart 6), compared with -2.3 and 3.9 per cent of GDP, respectively, in the baseline scenario.[23]

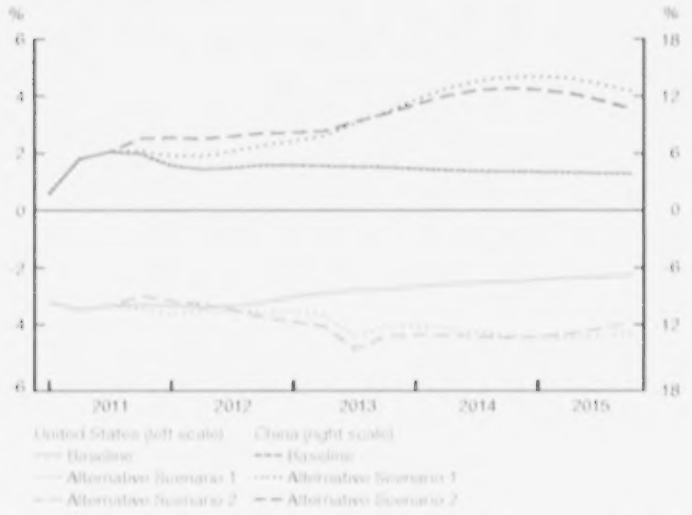
The insufficient demand generated in Alternative Scenario 1, combined with the constraint on nominal policy rates from the effective lower bound in Europe, Japan and the United States, leads to higher real interest rates.

22 We assume a decline of 20 per cent in the stock markets of other emerging market economies and a decline of 15 per cent in those of the United States, Europe and other advanced economies relative to the baseline scenario. Given the sovereign debt crisis in Europe, the greater uncertainty in China and other emerging market economies in Asia leads to an additional rise in the perceived risk of the European sovereign debt (sovereign risk premiums increase by 40 basis points) and a 3.5 per cent decline in outstanding loans relative to the baseline scenario.

23 This is comparable with the results obtained by the International Monetary Fund for the G-20 Mutual Assessment Process (MAP), in which the adoption of fiscal consolidation, rebalancing policies and structural reforms leads to a decline of 7 percentage points in China's current account surplus and a decline of 1.6 percentage points in the U.S. current account deficit over the 2011–16 period (IMF 2011). Moreover, in the MAP scenario, the U.S. real effective exchange rate depreciates by about 10 per cent over 2011–16, while the Chinese real effective exchange rate appreciates by roughly the same amount, which is also similar to the results obtained in our simulations. In contrast to our scenarios, however, the simulations for the G-20 MAP do not contain the important assumptions leading to a severe contraction in output due to (i) the increase in risk premiums following the failure to consolidate on the part of the United States and Europe, and (ii) the hard landing in China and the other emerging market economies of Asia.

Chart 6: **Alternative scenarios—current account balances in the United States and China**

As a percentage of respective GDP

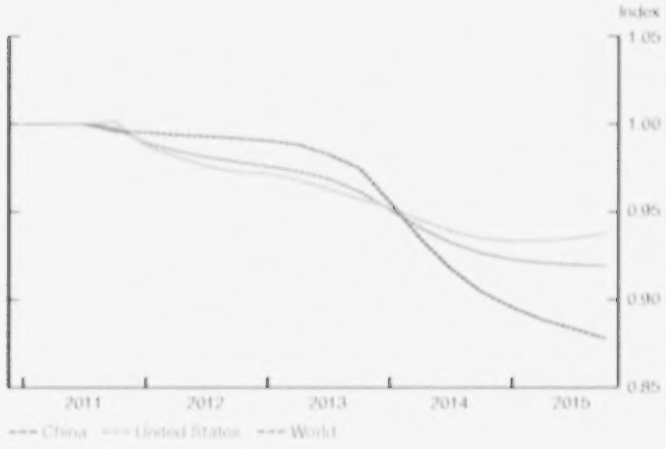


Note: Dotted lines indicate projections.
Sources: GMUSE and BoC GEM-Fin simulations

Last observation: June 2011

Chart 7: **Alternative Scenario 1—GDP relative to the baseline scenario**

Index, 2011Q2 = 1



Note: Dotted lines indicate projections.
Sources: GMUSE and BoC GEM-Fin simulations

Last observation: June 2011

This insufficient demand also generates strong deflationary pressure in developed countries that will last until 2016, with inflation rates reaching a trough of approximately -2.5 per cent in the United States and Europe.[24]

In terms of economic growth, Alternative Scenario 1 results in reduced GDP across regions (Chart 7). By 2015, the lack of required policy measures produces an 8 per cent loss in world GDP (US$6 trillion at 2009 prices) relative

24. The negative effect of deflation on aggregate demand is somewhat dampened by the implementation of quantitative easing (QE) measures in the United States and Europe. We assume that these measures would result in a persistent reduction of 50 basis points in the long-run interest rates. This is in line with most estimates of the effect on Treasury yields of the 2008 Treasury bond purchases by the Federal Reserve (Krylova, Santor and Suchanek 2011). However, considerable uncertainty remains regarding the size and effectiveness of the QE measures.

to the baseline scenario. During the same period, the U.S. GDP is lower by 6 per cent relative to the baseline scenario, while the decline in Chinese GDP is 12 per cent.

Alternative Scenario 2: Front-Loaded Fiscal Consolidation in the United States and Europe

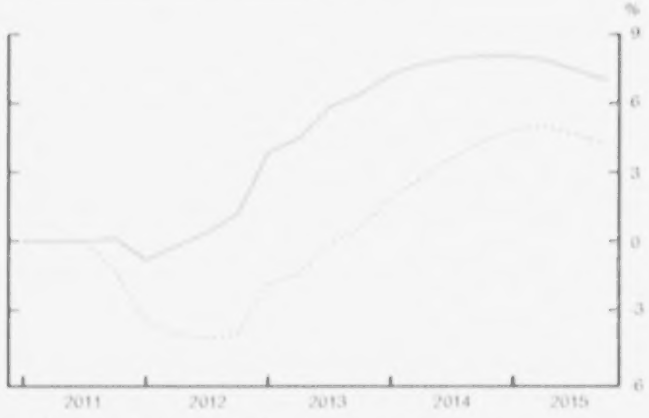
In Alternative Scenario 2, we maintain the lack of adjustments to exchange rates and structural reforms in China and the other emerging-market economies of Asia, as well as the absence of structural reforms in Europe and Japan. We assume, however, that the fiscal consolidation in the United States and Europe is front-loaded, compared with the baseline scenario. In addition, we assume that concerns about the sovereign debt crisis in Europe lead to a rise in sovereign risk spreads of about 190 basis points.[25]

The projected paths for budget deficits in the United States and Europe are fairly similar. In the United States, the front-loaded fiscal consolidation results in a decline in the ratio of the deficit to GDP by about 4 percentage points by late 2012, relative to the baseline scenario (Chart 8). By mid-2013, however, the spillover effects on U.S. GDP resulting from the hard landing in the emerging-market economies of Asia and from the lack of structural reforms in Europe and Japan cause the deficit-to-GDP ratio to rise above the level in the baseline scenario.[26]

In Europe, the front-loaded fiscal consolidation implies a deficit reduction of more than 5 percentage points by mid-2013, compared with Alternative Scenario 1 with delayed fiscal consolidation. In the long run, the ratio of deficit to GDP in Alternative Scenario 2 stabilizes at the same level as in the baseline scenario, which is about 2 percentage points lower than that in Alternative Scenario 1.

Chart 8: **U.S. government deficit**

Difference from baseline, as a percentage of GDP



Note: Dotted lines indicate projections.
Sources: GMUSF and BoC GEM-Fin simulations

Last observation: June 2011

25 This is roughly similar to the 160 basis point increase in government spreads (the rate for 10 year government bonds versus rates for The Euro OverNight Index Average (EONIA)) observed between October 2010 and January 2012, despite the fiscal consolidation efforts undertaken in many countries over this period. Given that spreads have remained relatively stable in the United States over the same period, we do not impose an increase in spreads in the United States in this scenario.

26 The magnitude of the change in the fiscal deficit in Alternative Scenario 2 is similar to that in the baseline scenario.

Outcomes under Alternative Scenario 2

In our simulation, the front-loaded fiscal consolidation in the United States and Europe mitigates, but does not resolve, global imbalances. Although both the current account deficit in the United States and the surplus in China are lower in this scenario by 2015, relative to Alternative Scenario 1 (in which fiscal consolidation is delayed), they remain larger than in the baseline (Chart 6). In this scenario, the lack of adjustment in exchange rates and domestic demand in China and the other emerging-market economies of Asia prevents the resolution of global imbalances.

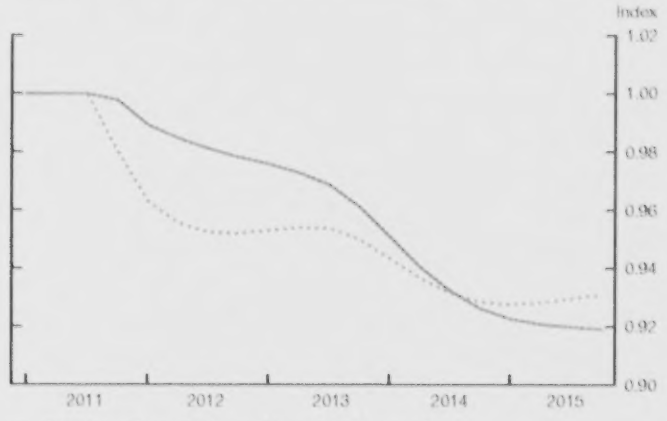
The front-loaded fiscal consolidation in the United States and Europe mitigates, but does not resolve, global imbalances

When the United States and Europe undertake front-loaded fiscal consolidation, global GDP is lower than when fiscal consolidation is delayed—until late 2014, after which there is a reversion. In both Alternative Scenario 1 (delayed fiscal consolidation) and Alternative Scenario 2 (front-loaded fiscal consolidation), global GDP is substantially lower by 2015 than in the baseline scenario (Chart 9)—by 8 per cent and 7 per cent, respectively. Weaker growth in output in the first two years causes advanced economies to experience significant deflation.[27] In Alternative Scenario 2, the trough in inflation (around -4 per cent in the United States) is lower than in Alternative Scenario 1 (around -2.5 per cent in the United States). Moreover, in Alternative Scenario 2, the trough in inflation is reached one year earlier, at the end of 2012. Eventually, permanently lower government bond spreads in the United States and Europe, relative to Alternative Scenario 1, outweigh the short-term negative effect on GDP from the front-loaded fiscal consolidation. Nevertheless, when the GDP losses observed in the two alternative scenarios relative to the baseline scenario are computed in terms of net present values (using the BoC-GEM-Fin real discount rate of 3 per cent per year), cumulative losses under Alternative Scenario 2 are almost 10 per cent greater than those under Alternative Scenario 1. Thus, in Alternative Scenario 2, the lack of domestic demand in China and the other emerging-market economies of Asia needed to offset the lost demand resulting from the fiscal adjustment in advanced economies plays a crucial role in explaining the shortfall in global demand.

In Alternative Scenario 2, the lack of domestic demand in the emerging-market economies of Asia plays a crucial role in explaining the shortfall in global demand

Chart 9: **Alternative scenarios—global GDP relative to the baseline scenario**

Index: 2011Q2 = 1



Note: Dotted lines indicate projections.
Sources: GMUSE and BoC-GEM-Fin simulations

Last observation: June 2011

27 When interest rates are near the effective lower bound, deflation poses many risks to the economy, including the possibility of unanchored inflation expectations, which would increase real interest rates and, consequently, real debt burdens. These risks can lead to a protracted weakness in the domestic economy.

Sensitivity Analysis

To gauge the importance of the main assumptions in Alternative Scenario 1 (with delayed fiscal consolidation), we divide the total loss of global output (8 per cent) relative to the baseline scenario, according to the contribution of the various components (**Table 1**). The delayed fiscal consolidation in the United States and Europe explains approximately 3.6 percentage points of the loss in output, while the delayed adjustments in China and the other emerging-market economies of Asia account for another 3.6 percentage points. Finally, the lack of structural reforms in Europe and Japan explains 0.8 percentage point of the total loss. Thus, in Alternative Scenario 1, not implementing the policy measures in advanced economies and in emerging-market economies in Asia accounts for roughly equal shares of the total loss of global output.

◀ *In Alternative Scenario 1, not implementing the policy measures in advanced economies and in emerging-market economies in Asia accounts for roughly equal shares of the total loss of global output*

Table 1: **Sensitivity analysis of the loss of global output**

Components of Alternative Scenario 1	Contribution to the decline in global gross domestic product (percentage points, by the end of 2015)
Delayed fiscal consolidation in the United States and Europe	3.6
Lack of adjustment and a hard landing in China and the other emerging-market economies of Asia	3.6
Lack of structural reforms in Europe and Japan	0.8

Concluding Remarks

Under a baseline scenario characterized by a combination of fiscal consolidation in the United States and Europe, flexible exchange rates and structural policies to stimulate domestic demand in the emerging-market economies of Asia, and structural reforms in Europe and Japan, we find that global current account imbalances could be gradually reduced over the medium term. Our first alternative scenario illustrates that if all the necessary policies described above are delayed, not only could the correction of global imbalances be undermined, but world economic growth could also be reduced. Our simulations also suggest that, in a second alternative scenario in which only the United States and Europe implement some of the policies favourable to reducing global imbalances, these imbalances could be reduced but would remain far from the convergence observed in the baseline. As well, global GDP would be lower than in the baseline scenario by 2015, and the losses relative to the baseline, when measured in terms of real net present values, would be almost 10 per cent greater than in the first alternative scenario over the next five years. Overall, our analysis suggests that if left unresolved, the global imbalances could have severe negative consequences for global economic growth and financial stability.

Literature Cited

Baldacci, E. and M. S. Kumar. 2010. "Fiscal Deficits, Public Debt, and Sovereign Bond Yields." International Monetary Fund Working Paper No. WP/10/184.

Beaton, K., C. de Resende, R. Lalonde and S. Snudden. 2010. "Prospects for Global Current Account Rebalancing." Bank of Canada Discussion Paper No. 2010-4.

Bini Smaghi, L. 2011. "The Triffin Dilemma Revisited." Speech at the Conference on the International Monetary System, at the Triffin International Foundation, Brussels, Belgium, 3 October.

Bouis, R. and R. Duval. 2011. "Raising Potential Growth After the Crisis: A Quantitative Assessment of the Potential Gains from Various Structural Reforms in the OECD Area and Beyond." Organisation for Economic Co-operation and Development Economics Department Working Paper No. 835.

Cerra, V. and S. C. Saxena. 2008. "Growth Dynamics: The Myth of Economic Recovery." *American Economic Review* 98 (1): 439–57.

Ciarlone, A. 2011. "Housing Wealth Effect in Emerging Economies." *Emerging Markets Review* 12 (4): 399–417.

de Resende, C. and R. Lalonde. 2011. "The BoC-GEM-Fin: Banking in the Global Economy." *Bank of Canada Review* (Summer): 11–21.

International Monetary Fund (IMF). 2011. *G-20 Mutual Assessment Process: From Pittsburg to Cannes—IMF Umbrella Report*. IMF Staff Report for the G-20 Mutual Assessment Process No. 1.

Kozicki, S., E. Santor and L. Suchanek. 2011. "Unconventional Monetary Policy: The International Experience with Central Bank Asset Purchases." *Bank of Canada Review* (Spring): 13–25.

Laubach, T. 2003. "New Evidence on the Interest Rate Effects of Budget Deficits and Debt." Federal Reserve Board Finance and Economics Discussion Series Working Paper No. 2003-12.

———. 2011. "Fiscal Policy and Interest Rates: The Role of Sovereign Default Risk." *NBER International Seminar on Macroeconomics* 7 (1): 7–29.

Little, B. and R. Lafrance. 2006. "Global Imbalances—Just How Dangerous?" *Bank of Canada Review* (Spring): 3–13.

Obstfeld, M. and K. Rogoff. 2009. "Global Imbalances and the Financial Crisis: Products of Common Causes." In *Asia Economic Policy Conference*, 131–72. Proceedings of a conference held by the Federal Reserve Bank of San Francisco, October 2009. San Francisco: Federal Reserve Bank of San Francisco.

Peltonen, T. A., R. M. Sousa and I. S. Vansteenkiste. 2009. "Wealth Effects in Emerging Market Economies." European Central Bank Working Paper No. 1000.

Reinhart, C. M. and K. S. Rogoff. 2009. "The Aftermath of Financial Crises." National Bureau of Economic Research Working Paper No. 14656.

Santor, E. and L. Schembri. 2011. "The International Monetary System: An Assessment and Avenue for Reform." *Bank of Canada Review* (Autumn): 1–11.

Schuknecht, L., J. von Hagen and G. Wolswijk. 2010. "Government Bond Risk Premiums in the EU Revisited: The Impact of the Financial Crisis." European Central Bank Working Paper No. 1152.

Inflation Targeting: The Recent International Experience

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- In the years since the 2006 renewal of Canada's inflation-control agreement, inflation-targeting (IT) regimes have faced significant shocks, including the global economic and financial crisis.
- These challenges highlighted the value of inflation targeting. The regime's capacity to firmly anchor inflation expectations gave central banks greater scope to respond to the shocks.
- In the aftermath of the crisis, both the United States and Japan adopted numerical inflation objectives.
- The crisis has motivated a vigorous debate about the appropriate role for financial stability considerations within monetary policy frameworks. Several countries, including Canada, have since reviewed the role of financial stability considerations in their monetary policy frameworks.
- Overall, a flexible IT framework, supported by central bank independence, accountability and clear communications, remains a robust monetary policy approach to promoting economic welfare.

In November 2011, the Government of Canada and the Bank of Canada renewed their inflation-control agreement for another five years (Bank of Canada 2011). The experience of the recent crisis and international developments in the design of inflation-targeting (IT) frameworks informed, in part, this latest renewal. Paulin (2006) documents the evolution of IT frameworks from their inception in 1990 to Canada's 2006 renewal (Bank of Canada 2006). This article updates Paulin's survey by reviewing the recent experience with inflation targeting, the adoption of numerical inflation objectives by the United States and Japan, and the debate about the appropriate design of IT frameworks in light of the global economic and financial crisis.[1]

Since 2006, monetary policy frameworks have faced significant challenges—most importantly, the global economic and financial crisis. The financial crisis that began in late 2007 was followed by a large and persistent decline in aggregate demand. This resulted in downward pressure on inflation, leading many central banks to cut their policy rates to the effective lower bound. Firmly anchored inflation expectations left IT countries well equipped

1. We focus on the experience in advanced economies.

to face these challenges. IT frameworks proved resilient through the crisis and were left relatively unchanged after these traumatic events, reinforcing the value of inflation targeting.

Among advanced economies, the United States and Japan had been notable exceptions to the trend toward inflation targeting.[2] In the aftermath of the crisis, both countries adopted numerical inflation objectives; however, neither the Federal Reserve nor the Bank of Japan has declared itself to be an inflation targeter. Moreover, the crisis led to a vigorous debate regarding the appropriate role of financial stability considerations within the monetary policy framework.

The Recent Experience with Inflation Targeting

Three broad findings emerge from empirical studies of inflation targeting done before the crisis:

(i) Inflation targeters have been successful in achieving and maintaining low inflation, but it is difficult to establish a causal relationship because of the general shift to low inflation during the 1990s and early 2000s, even among non-IT countries (Ball and Sheridan 2004; Lin and Ye 2007).

(ii) Inflation targeting has not led to any increase in the volatility of real economic activity among IT countries (Lin and Ye 2007; Walsh 2009).

(iii) Inflation expectations are more firmly anchored in IT countries than in non-IT countries (Gürkaynak, Levin and Swanson 2006; Gürkaynak et al. 2007; Levin, Natalucci and Piger 2004).

Although the years between the 2006 and 2011 renewals of Canada's inflation-control agreement were the most turbulent since inflation targeting was first adopted, the global economic and financial crisis did not overturn these findings. In fact, well-anchored inflation expectations afforded IT central banks considerable flexibility in responding to these shocks.

◀ *The years between the 2006 and 2011 renewals of Canada's inflation-control agreement were the most turbulent since inflation targeting was first adopted*

The global economic and financial crisis (2007–09)

In many advanced economies, the recession that began in late 2007 was the deepest since the Great Depression. Some have argued that inflation targeting played an important role in causing the crisis by requiring central banks to focus on price stability to the exclusion of other economic and financial developments. This assertion ignores both the reality of flexible inflation targeting and the fact that only one IT country, the United Kingdom, was at the epicentre of the financial crisis (Carney 2012). Nevertheless, most IT countries were affected by spillover effects through trade, financial and confidence channels.

The recession was deep and persistent in many of the affected advanced economies because of the severe impairment of their financial systems. Its persistence stemmed from the need, in many countries, for banks, governments and households to deleverage.

The recession led to significant excess supply in most advanced economies, which put downward pressure on inflation and motivated many central banks to cut their policy interest rates to the effective lower bound. With conventional policy thus constrained, central banks in both crisis and

2 Although the European Central Bank (ECB) has a numerical inflation objective of "below, but close to, 2% over the medium term" (ECB 2012), it does not consider itself an inflation targeter. Nevertheless, its policy framework includes many of the elements of inflation targeting. See Paulin (2006) for a discussion of the ECB's framework.

non-crisis economies turned to unconventional policy measures, using tools that often involved varying the size and composition of their balance sheets. Evidence suggests that the implementation of credit easing and central bank asset purchases succeeded in reducing credit spreads and yields.[3]

Some central banks also used "forward guidance" to provide additional easing. Several IT central banks that were already publishing conditional projections for their policy interest rate[4] continued to provide markets with guidance regarding the projected path of the policy rate, consistent with achieving their inflation targets over a given horizon. Other central banks, including the Bank of Canada, departed from their normal practice to provide extraordinary forward guidance.

In April 2009, the Bank of Canada lowered the target overnight rate to 25 basis points (the estimated effective lower bound) and committed to keep the rate there until the end of the second quarter of 2010, conditional on the outlook for inflation. This constituted unconventional policy for the Bank, since it was outside the scope of its normal monetary policy communications. The Federal Reserve adopted a similar strategy in August 2011, announcing that it expected economic conditions "to warrant exceptionally low levels for the federal funds rate at least through mid-2013" (FOMC 2011).[5]

The Bank of Canada ultimately raised the target overnight rate before the end of the original time frame. The early exit from the lower bound was motivated by changes in economic conditions and the outlook for inflation. The Bank's inflation target facilitated communication of the explicit conditionality of the commitment, helping markets to anticipate the need for the early exit. The Fed's recent adoption of flexible inflation targeting may similarly facilitate communication of its eventual exit from the lower bound.

Assessing the contribution of IT frameworks to economic performance during the crisis is not straightforward. The shocks affecting economies were heterogeneous: some economies suffered banking and financial crises, while others, including Canada, experienced strong spillover effects from beyond their borders, both in the real economy and in the financial sector. In addition, some non-IT central banks, including the Fed, took actions similar to those of the IT central banks.

Among advanced economies, however, inflation declined less, on average, in IT countries than in non-IT countries. This was not merely a consequence of differences in the depth of the recession in those economies. The ratios of changes in inflation to the percentage declines in output from peak to trough were, on average, almost four times larger in non-IT countries than in IT countries. Although inconclusive, this suggests that inflation was less sensitive to changes in demand in IT countries, perhaps because of better-anchored expectations.

Among advanced economies, inflation declined less, on average, in IT countries than in non-IT countries

Headline inflation rates were nevertheless quite volatile during the 2006–11 period. Most IT countries experienced an increase in inflation before the crisis, as global commodity prices rose rapidly (see **Box 1**). Inflation then fell sharply following the collapse in global demand caused by the crisis and the related collapse in commodity prices. This volatility was

3. See Kozicki, Santor and Suchanek (2011) for a review of the international experience with central bank asset purchases.

4. These banks included, as of late 2008, the Reserve Bank of New Zealand, Norges Bank (Norway), Sveriges Riksbank (Sweden), the Central Bank of Iceland and the Czech National Bank.

5. This was subsequently extended to 2014.

Box 1

The Global Commodity-Price Boom (2007–08)

Large and persistent shocks to commodity prices can generate a trade-off between inflation and output stabilization. In such situations, central banks, particularly IT central banks, must choose whether to return inflation to target over their normal horizon, at the cost of generating some volatility in output, or to return inflation to target over a horizon that is longer than normal to mitigate the effects on output.

During the 2007–08 period, many central banks had to make this choice, as the prices of several key commodities rose rapidly and persistently. The energy component of the Bank of Canada Commodity Price Index (BCPI), for example, rose 124 per cent from the beginning of 2007 to its peak in mid-2008. Similarly, the agriculture component rose 74 per cent between January 2007 and February 2008. These dramatic price increases were preceded by decade-long trends, in which energy prices increased more than eightfold, while prices for agricultural products more than doubled, resulting in persistent upward pressure on inflation in Canada and abroad.

Among advanced IT economies, headline inflation was more than 1 percentage point above target for a longer time over this period than during the preceding five years (**Table 1-A**), and several of these countries experienced inflation above the 1-percentage-point threshold for more than half of the months during that time. Nevertheless, among advanced economies, none of the inflation targeters changed the parameters of its IT framework (such as the width of the target band or the targeted price index) in response to commodity-price pressures (Stone et al. 2009).

Table 1-A: **Periods when inflation was more than 1 percentage point above target in advanced IT economies**

	Percentage of months	
	2001–06	2007–08
Canada	14	19
Iceland	64	95
Norway	11	24
United Kingdom	0	29
Switzerland	0	5
Sweden	3	52
Euro area	1	52
Australia[a]	17	43
New Zealand[a]	29	57

a. Figures are a percentage of quarters, rather than of months.
Sources: National statistics agencies and Bank of Canada calculations

Despite the rise in short-term (i.e., one-year-ahead) inflation expectations during the commodity-price boom, expectations remained within the target range in most IT countries, and medium- and long-term expectations remained well anchored (Cunningham, Desroches and Santor 2010; Martínez 2009). Overall, IT frameworks proved sufficiently credible to allow inflation to deviate from target for longer-than-normal periods without increasing medium-term inflation expectations.

associated with some movement in short-term inflation expectations, but medium- and long-term expectations remained well anchored in IT countries (Cunningham, Desroches and Santor 2010; Martinez 2009). Even short-term (one-year-ahead) expectations remained within the target range in most IT countries (**Chart 1**). Thus, short-term inflation expectations were far less volatile than actual inflation, as one would expect in a credible IT regime.

Despite a volatile inflation environment, medium- and long-term expectations remained well anchored in IT countries

De Carvalho Filho (2011) provides a very broad analysis of 51 IT and non-IT countries (both advanced and emerging-market economies) following the crisis. He finds that IT countries cut interest rates more aggressively than their non-IT counterparts and were less likely to face "deflation scares."[6] IT countries were able to cut rates aggressively, not only because they happened to have higher nominal and real interest rates on the eve of the crisis, but also because they had better-anchored inflation expectations. Although de Carvalho Filho finds no differences in unemployment dynamics, IT countries did have superior growth performance in the two years after the crisis began. He argues that the positive effects of inflation targeting cannot be explained by other pre-crisis determinants or indicators of post-crisis economic performance.[7]

The Adoption of Numerical Inflation Objectives in the United States and Japan

Among advanced economies, the United States and Japan were notable exceptions to the trend toward inflation targeting. In the aftermath of the crisis, both countries adopted numerical inflation objectives; however, neither the Federal Reserve nor the Bank of Japan has declared itself to be an inflation targeter.

In the aftermath of the crisis, both the Federal Reserve and the Bank of Japan adopted numerical inflation objectives; however, neither has declared itself to be an inflation targeter

The changes in these countries move both of them toward the type of flexible IT framework in place in Canada and many other countries, since a medium-term numerical inflation objective is the centrepiece of such a framework. The focus on inflation, however, is a means to an end, the end being the promotion of economic well-being. Under flexible inflation targeting, the central bank seeks to return inflation to its medium-term target while mitigating volatility in other dimensions of the economy, such as employment and financial stability, that matter for welfare.

The United States

The Federal Reserve Act establishes "maximum employment, stable prices, and moderate long-term interest rates" as the objectives of U.S. monetary policy. These statutory objectives are often referred to as the Federal Reserve's "dual mandate," since the third goal (moderate long-term interest rates) is inexorably linked to the second (stable prices).

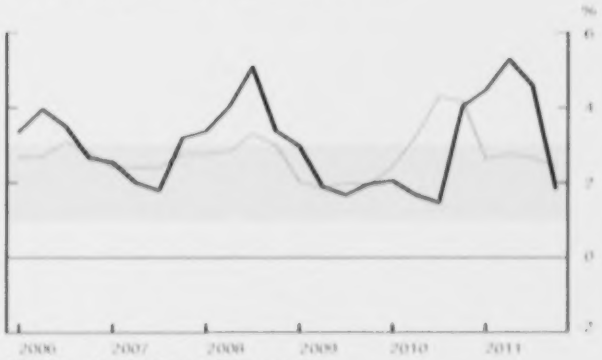
In January 2012, the Federal Open Market Committee (FOMC)—the policy-making body of the Federal Reserve System—released a statement of principles (see FOMC 2012) regarding its longer-run goals and monetary policy strategy. The FOMC stated that an inflation rate of "2 percent, as measured by the annual change in the price index for personal consumption expenditures, is most consistent over the longer run with the Federal Reserve's

6 A deflation scare is defined as three consecutive negative readings of the monthly inflation rate (de Carvalho Filho 2011).

7 Determinants that are controlled for include the growth of private credit, ratios of reserves to gross domestic product (GDP) and short-term debt, capital inflows, trade openness, the current account balance, and exchange rate flexibility.

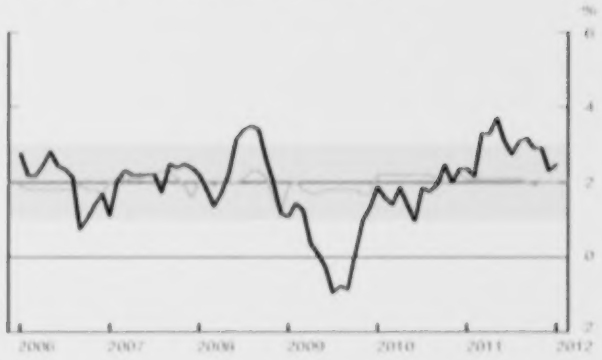
Chart 1: Inflation-control targets in selected advanced economies

a. New Zealand
Year-over-year percentage change, quarterly data



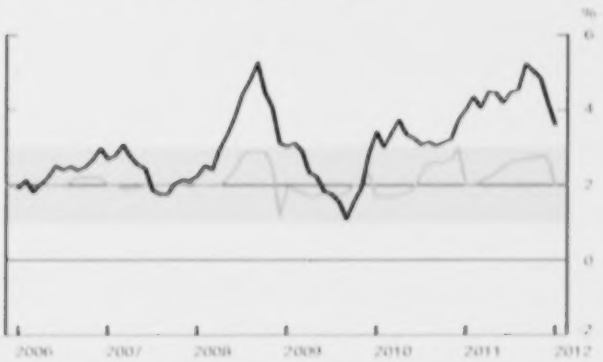
Note: New Zealand targets the range of headline CPI. Last observation: 2011Q4

b. Canada
Year-over-year percentage change, monthly data



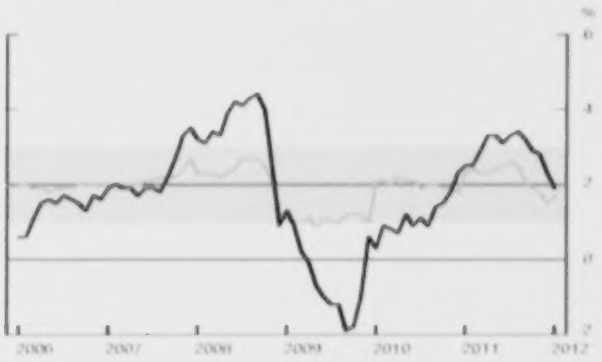
Last observation: January 2012

c. United Kingdom
Year-over-year percentage change, monthly data



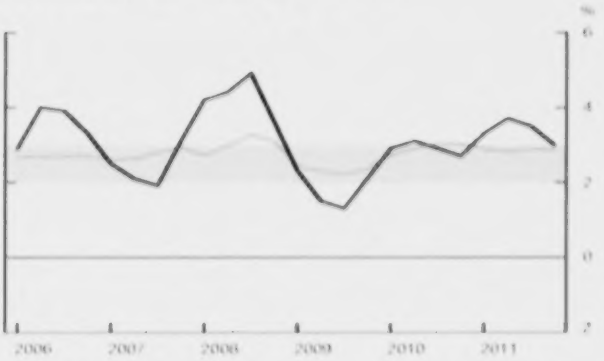
Note: The United Kingdom does not have an official target range, but puts special emphasis on any deviations of more than ±1 percentage point. Last observation: January 2012

d. Sweden
Year-over-year percentage change, monthly data



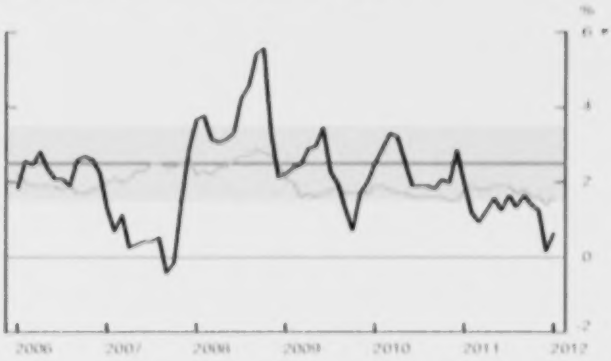
Last observation: January 2012

e. Australia
Year-over-year percentage change, quarterly data



Note: Australia targets the range of headline CPI. Last observation: 2011Q4

f. Norway
Year-over-year percentage change, monthly data



Note: Norway does not have an official target range, but puts special emphasis on any deviations of more than ±1 percentage point. Last observation: January 2012

Target range — Inflation target --- Inflation expectation (for the year ahead) — Headline inflation

Sources: National central banks and statistics agencies, Consensus Economics, and Bank of Canada calculations

statutory mandate."[8] This interpretation of its mandate effectively rendered the Fed a flexible inflation targeter.[9]

Adopting a numerical inflation target had long been discussed as an option for U.S. monetary policy. The debate had centred on the Fed's dual mandate, with some observers expressing concerns that an inflation target would give price stability priority over the promotion of maximum employment. The FOMC (2012) addressed this issue in its statement, noting that a clear inflation goal "helps keep longer-term inflation expectations firmly anchored, thereby . . . enhancing the Committee's ability to promote maximum employment in the face of significant economic disturbances."

The Fed's flexible IT framework has several notable institutional features (**Table 1**):

(i) Like the Riksbank in Sweden, the European Central Bank (ECB) and the Bank of Japan, the FOMC unilaterally interpreted its mandate. In many countries, the mandate is instituted by the government or by mutual agreement between the government and the central bank.

(ii) The principles underlying the framework are subject to annual renewal.[10] Only the United Kingdom and Japan renew as frequently. Frequent renewal could lead to questions regarding the strength of the commitment to inflation targeting; however, in practice, such issues tend to be resolved with experience.

(iii) The inflation target is characterized as a long-run goal of monetary policy, whereas most IT central banks aim to return inflation to target over the medium term. In a flexible IT framework, however, the horizon for returning inflation to target generally depends on the size and nature of the shocks hitting the economy. Thus, the practical implications of the long-run characterization of the target may be limited.

The Fed's experience with these distinctive aspects of its framework may yield insights into the optimal design of IT regimes.

Japan

The Bank of Japan recently attempted to clarify its interpretation of its statutory price-stability mandate, specifying that the "goal" for medium- to long-term inflation is "in a positive range of 2 percent or lower in terms of the year-on-year rate of change in the consumer price index (CPI)." Moreover, it established a "goal at 1 per cent for the time being" (Bank of Japan 2012). The 1 per cent goal is lower than the numerical inflation objectives of other countries, most of which are around 2 per cent (**Table 1**). The Bank of Japan emphasized that this numerical inflation objective would "further clarify the determination to overcome deflation and achieve sustainable growth with price stability."

The Bank of Japan characterized its inflation objective as a "goal" and avoided using the term "target." Some observers have argued that the "Japanese translation of 'goal'—taken by some to be a synonym for

8. Most other central banks target a consumer price index (CPI) rather than a deflator for personal consumption expenditures (PCE). The PCE deflator differs from the CPI in several ways: (i) the weights of the PCE deflator change every quarter, thereby mitigating substitution bias in the measured inflation rate; (ii) the PCE deflator is subject to revisions; and (iii) there are differences in scope.

9. Even before this announcement, interpretations of the committee's mandate by individual FOMC participants were broadly consistent with a 2 per cent inflation target. See Evans (2011) for a detailed discussion.

10. The 2012 FOMC announcement stated, "The Committee intends to reaffirm these principles and to make adjustments as appropriate at its annual organizational meeting each January" (FOMC 2012).

Table 1: **Monetary policy frameworks in selected countries**

Country	Date adopted	Current inflation target	Target variable	Policy horizon[a]	Target set by	Frequency of renewal
New Zealand	March 1990	1–3 per cent range (no specified midpoint)	CPI (with caveats for some deviations)	Medium term	PTA (most recently in 2002) between RBNZ Governor and Minister of Finance	Usually renewed at the start of each governor's 5-year term
Canada	February 1991	2 per cent midpoint in 1–3 per cent range	CPI (operationally use core CPI)	6–8 quarters	Government and central bank	Currently renewed every 5 years
United Kingdom	October 1992	2 per cent (±1 per cent, but not a target range)	CPI (based on the European Union harmonized index)	Medium term	Government	Currently renewed annually
Sweden	January 1993	2 per cent, ±1 per cent	CPI (emphasis on underlying measures of inflation)	2 years	Central bank	No renewal since adoption
Australia	March 1993	2–3 per cent, on average, over the business cycle	CPI	Medium term	Government and central bank	Renewed in 1996, 2003, 2006, 2007, 2010
Euro area[b]	January 1999	Below, but close to, 2 per cent	HICP	Medium term	Central bank	Target clarified in 2003
Switzerland[b]	January 2000	Less than 2 per cent	CPI	2–3 years	Central bank	No institutional commitment to inflation targeting in its monetary policy objectives
Norway	March 2001	Approximately 2½ per cent (±1 per cent, but not a target range)	CPI (emphasis on a core measure of the CPI)	1–3 years	Government	No renewal since adoption
United States[c]	January 2012	2 per cent	PCEPI	Medium term	Central bank	No renewal since adoption
Japan[c]	February 2012	1 per cent	CPI	Medium to long term	Central bank	Will be renewed annually

a. The policy horizon may be defined differently across IT regimes. Here it indicates the time period most commonly emphasized by the central bank.

b. The European Central Bank and the Swiss National Bank do not consider inflation targeting the goal of their monetary policy regimes.

c. The Federal Reserve and the Bank of Japan do not use the word "target" to describe their inflation objectives.

Note: CPI = consumer price index, PTA = Policy Targets Agreement, HICP = harmonized index of consumer prices, RBNZ = Reserve Bank of New Zealand, PCEPI = personal consumption expenditures price index.

'target'—is far more non-committal than in English" (Ito 2012). However, the Governor of the Bank of Japan, Masaaki Shirakawa (2012, 3–4), stated, "The basic idea of the 'goal' introduced is largely in line with the basic thinking held by some central banks abroad with regard to using the word 'a target.'" He explained the Bank of Japan's avoidance of the word "target" by noting that the term "inflation targeting" has acquired a narrow mechanical connotation in Japan.[11]

11. According to Shirakawa (2012, 4), "In Japan, . . . it is still often the case that 'inflation targeting' is mistakenly considered equivalent to conducting monetary policy in an automatic manner in pursuit of a certain inflation rate. In reality, in many countries, including those adopting inflation targeting, monetary policy is conducted not in such an automatic manner but with an emphasis on price and economic stability in the medium to long term."

Monetary Policy and Financial Stability

The crisis made it clear that price stability does not guarantee financial stability. This sparked a debate on the appropriate role of monetary policy in maintaining financial stability. As part of the process leading to the 2011 renewal of the inflation-control agreement in Canada, the Bank undertook a review of this role.

The crisis made it clear that price stability does not guarantee financial stability, sparking a debate on the appropriate role of monetary policy in maintaining financial stability

As explained in Bank of Canada (2011), the crisis underlined the importance of focusing on financial imbalances fuelled by a credit boom. Excessive indebtedness caused by such a boom poses the greatest risk because the accumulation of debt can be unwound only through a period of deleveraging, which, if prolonged, is usually associated with persistently deficient demand.

Moreover, a stable economic environment, unless accompanied by prudential regulation at both the macro and micro levels, can contribute to the buildup of financial imbalances if perceived risk declines and the capacity of the financial sector to take on leverage increases. Indeed, risk can be at its greatest when measures of risk are at their lowest. Perceived certainty about the stability of low interest rates can play a particularly important role in reinforcing the tendency to overreach. In short, complacency can lead to a buildup of financial imbalances.

A stable economic environment, unless accompanied by prudential regulation at both the macro and micro levels, can contribute to the buildup of financial imbalances

The crisis also made it clear that strong individual financial institutions, while necessary, are not sufficient to ensure the safety and soundness of the financial system as a whole. In addition, the tight and complex links among financial institutions and markets were shown to be capable of generating, transmitting and amplifying shocks with significant consequences for the system.

The first line of defence against a buildup of such financial imbalances is responsible behaviour by individuals and institutions. The second is regulatory and supervisory policy, or what might be called "microprudential" policy. Reflecting the lessons of the crisis, the microprudential approach is also being enhanced by the adoption of a system-wide perspective, with the development of new macroprudential measures.[12] These defences will mitigate the risk of financial excesses, but, in some cases, monetary policy may still have to take financial stability considerations into account, most obviously, when financial imbalances affect the near-term outlook for output and inflation (Bank of Canada 2011).

In this context, the Bank concluded that, in some exceptional circumstances, when financial imbalances pose an economy-wide threat or where imbalances themselves are being encouraged by a low-interest-rate environment, monetary policy itself may be needed to support financial stability (Bank of Canada 2011). Monetary policy has a broad influence on financial markets and on the leverage of financial institutions that cannot be easily avoided. While this bluntness makes monetary policy an inappropriate tool to deal with sector-specific imbalances, it can be useful when addressing imbalances that may have economy-wide implications (Boivin, Lane and Meh 2010).

Because the consequences of financial excesses may be felt over a longer and more uncertain horizon than other economic disturbances, the potential may exist for tension among output, inflation and financial stability considerations over the typical two-year monetary policy horizon. In these

12 For example, the Government of Canada has already made several timely adjustments to the terms of mortgage financing. Additional measures, such as the countercyclical capital buffer and through-the-cycle margining, are under development.

circumstances, the Bank would need to use the flexibility available to it under the IT agreement to bring inflation back to target over a somewhat longer horizon, consistent with the longer-run pursuit of low, stable and predictable inflation.

Some other IT central banks have reviewed the role of financial stability considerations in the conduct of monetary policy.[13] In 2010, the Reserve Bank of Australia amended its Statement on the Conduct of Monetary Policy[14] to include a financial stability provision: "Without compromising the price stability objective, the Reserve Bank seeks to use its powers where appropriate to promote the stability of the Australian financial system" (Reserve Bank of Australia 2010). This statement suggests that promoting financial stability is a subordinate objective of monetary policy.[15] In practice, the extent to which Australia's approach would differ from the Bank of Canada's will depend on the interpretation of "compromising the price stability objective."

The Federal Reserve also made explicit provision for financial stability considerations in its flexible IT framework, indicating that monetary policy decisions would take into account "its assessments of the balance of risks, including risks to the financial system that could impede the attainment of the Committee's goals" (FOMC 2012). How risks to the financial system might affect policy decisions was not clarified. In particular, it is not clear to what extent the Fed would sacrifice inflation and employment performance over the short to medium term to mitigate risks to the financial system that might impede attainment of its goals over a longer horizon. Again, experience may provide additional clarity.

Finally, both the ECB and the Bank of Japan assign an explicit role to longer-term considerations in their policy frameworks. The Bank of Japan uses a "two-perspective approach" focusing on (i) economic and price conditions one or two years ahead, as well as (ii) long-run risk factors that have a low probability of materializing but may have a substantial impact on economic activity.[16] The ECB (2012) employs a similar "two-pillar approach" to achieving its price-stability objective: (i) "economic analysis," which focuses on the short- to medium-term determinants of inflation, such as real economic activity and financial conditions; and (ii) "monetary analysis," which focuses on longer-term determinants, including growth of money and credit. The focus on growth of money and credit distinguishes the ECB's approach from that of the Bank of Japan. Stark (2011) argues that "incorporating monetary phenomena in the policy framework inspires a sort of 'leaning-against-the-wind' stance which can help smooth financial cycles and stabilise the economy in the medium term." However, the ongoing European debt crisis—with its roots in fiscal as well as external imbalances within the euro area—arose despite these features of the monetary policy framework.

13 Some central banks, such as the Bank of England, have been assigned additional regulatory responsibilities to meet their financial stability objectives, but these responsibilities have no direct bearing on the conduct of their monetary policy regime.

14 The Statement on the Conduct of Monetary Policy is issued jointly by the Treasurer of Australia and the Governor of the Reserve Bank. It was most recently renewed in September 2010.

15 Sweden also conducted a review similar to the one done in Australia. The experience of the crisis led the Swedish parliament to commission an evaluation of the Riksbank's monetary policy for the 2005–10 period. In their report, Goodhart and Hofdal (2011) recommend that the Riksbank specify in more detail: (i) its exact mandate in promoting financial stability, (ii) the instruments that the Riksbank is entitled to use to achieve that goal, and (iii) the internal governance of the Riksbank with respect to financial stability and how it interacts with other public agencies sharing responsibility for financial stability. In April 2012, the Riksbank released a new communication policy to promote stability in the financial system.

16 See Shirakawa (2011) for details.

Concluding Remarks

The years between the 2006 and 2011 renewals of Canada's inflation-control agreement were the most turbulent since the advent of inflation targeting. Yet IT frameworks survived these challenges with few changes. The firm anchoring of expectations engendered by inflation targeting was a stabilizing force in an unstable world.

Explicit inflation targets also facilitated central bank communication through the crisis. The trend toward greater transparency was not impeded by the crisis. Indeed, in the aftermath of the crisis, the United States and Japan both adopted numerical inflation objectives.

The role of financial shocks and the transmission channels of those shocks in the crisis have highlighted the need for further research on the linkages between the real economy and the financial sector. This work is under way and is being incorporated into the policy models of central banks. Nevertheless, an improved understanding of the risk-taking channel of monetary policy, the interaction between monetary and macroprudential policies, and the use and performance of early-warning indicators would facilitate the design of monetary policy frameworks.

The experience of the crisis also fostered a debate on the merits of alternatives to inflation targeting, such as price-level targeting and nominal GDP targeting. The performance of these alternatives relative to inflation targeting depends critically on their ability to cause expectations to evolve in a beneficial way. Thus, the optimal design of a monetary policy framework depends on how expectations are formed and the effectiveness of central bank communications. For this reason, research on the formation of expectations that uses survey data and draws on experimental economics within the context of macroeconomic models should continue to be a priority.

Perhaps most fundamentally, the experience of recent years highlights the need for flexibility in research on monetary policy frameworks. The areas outlined above clearly warrant further study, but future work on the design of monetary policy should reflect our evolving understanding of our economic environment.

Literature Cited

Ball, L. and N. Sheridan. 2004. "Does Inflation Targeting Matter?" In *The Inflation-Targeting Debate*, 249–82. Edited by B. Bernanke and M. Woodford. Proceedings of a conference held by the National Bureau of Economic Research, January 2003. Chicago: University of Chicago Press.

Bank of Canada. 2006. "Renewal of the Inflation-Control Target: Background Information—November 2006." Available at <http://www.bankofcanada.ca/wp-content/uploads/2010/01/background_nov06.pdf>.

———. 2011. "Renewal of the Inflation-Control Target: Background Information—November 2011." Available at <http://www.bankofcanada.ca/wp-content/uploads/2011/11/background_nov11.pdf>.

Bank of Japan. 2012. "The Price Stability Goal in the Medium to Long Term." Press release, 14 February. Available at <http://www.boj.or.jp/en/announcements/release_2012/k120214b.pdf>.

Boivin, J., T. Lane and C. Meh. 2010. "Should Monetary Policy Be Used to Counteract Financial Imbalances?" *Bank of Canada Review* (Summer): 23–36.

Carney, M. 2012. "A Monetary Policy Framework for All Seasons." Speech to the U.S. Monetary Policy Forum, New York, New York, 24 February.

Cunningham, R., B. Desroches and E. Santor. 2010. "Inflation Expectations and the Conduct of Monetary Policy: A Review of Recent Evidence and Experience." *Bank of Canada Review* (Spring): 13–25.

de Carvalho Filho, I. E. 2011. "28 Months Later: How Inflation Targeters Outperformed Their Peers in the Great Recession." *The B.E. Journal of Macroeconomics* 11 (1): Article 22.

European Central Bank (ECB). 2012. "Strategy." Available under Monetary Policy at <http://www.ecb.europa.eu/mopo/strategy/html/index.en.html>.

Evans, C. L. 2011. "The Fed's Dual Mandate Responsibilities and Challenges Facing U.S. Monetary Policy." Speech to the European Economics and Financial Centre, London, England, 7 September.

Federal Open Market Committee (FOMC). 2011. "Press Release." Board of Governors of the Federal Reserve System. 9 August. Available at <http://www.federalreserve.gov/newsevents/press/monetary/20110809a.htm>.

———. 2012. "Press Release." Board of Governors of the Federal Reserve System. 25 January. Available at <http://www.federalreserve.gov/newsevents/press/monetary/20120125c.htm>.

Goodhart, C. and J.-C. Rochet. 2011. *Evaluation of the Riksbank's Monetary Policy and Work with Financial Stability 2005–2010*. Reports from the Riksdag 2010/11: RFR5. Stockholm: Riksdagstryckeriet.

Gürkaynak, R. S., A. T. Levin, A. N. Marder and E. T. Swanson. 2007. "Inflation Targeting and the Anchoring of Inflation Expectations in the Western Hemisphere." In *Monetary Policy Under Inflation Targeting*, 415–65. Edited by F. Mishkin and K. Schmidt-Hebbel. Santiago: Central Bank of Chile.

Gürkaynak, R. S., A. T. Levin and E. T. Swanson. 2006. "Does Inflation Targeting Anchor Long-Run Inflation Expectations? Evidence from Long-Term Bond Yields in the U.S., U.K., and Sweden." Federal Reserve Bank of San Francisco Working Paper No. 2006-09.

Ito, T. 2012. "BoJ's Last Chance to Jettison Defeatism." *Financial Times*, 24 April.

Kozicki, S., E. Santor and L. Suchanek. 2011. "Unconventional Monetary Policy: The International Experience with Central Bank Asset Purchases." *Bank of Canada Review* (Spring): 13–25.

Levin, A. T., F. M. Natalucci and J. M. Piger. 2004. "The Macroeconomic Effects of Inflation Targeting." Federal Reserve Bank of St. Louis *Review* 86 (4): 51–80.

Lin, S. and H. Ye. 2007. "Does Inflation Targeting Really Make a Difference? Evaluating the Treatment Effect of Inflation Targeting in Seven Industrial Countries." *Journal of Monetary Economics* 54 (8): 2521–33.

Martinez, G. O. 2009. "Inflation Targeting." In *A Festschrift in Honour of David Dodge*, 85–103. Proceedings of a conference held by the Bank of Canada, November 2008. Ottawa: Bank of Canada.

Paulin, G. 2006. "Credibility with Flexibility: The Evolution of Inflation-Targeting Regimes, 1990–2006." *Bank of Canada Review* (Summer): 5–18.

Reserve Bank of Australia. 2010. "Statement on the Conduct of Monetary Policy." 30 September. Available at <http://www.rba.gov.au/monetary-policy/framework/stmt-conduct-mp-5-30092010.html>.

Shirakawa, M. 2011. "150 Years of Innovation and Challenges in Monetary Control." Speech in celebration of the 150th anniversary of German-Japanese diplomatic relations, Frankfurt am Main, 8 March.

———. 2012. "The Bank of Japan's Efforts Toward Overcoming Deflation." Speech to the Japan National Press Club, Tokyo, 17 February.

Stark, J. 2011. "The Global Financial Crisis and the Role of Central Banking." Speech to the Institute of Regulation & Risk, Hong Kong, 12 April.

Stone, M. R., S. Roger, A. Nordstrom, S. Shimizu, T. Kisinbay and J. Restrepo. 2009. "The Role of the Exchange Rate in Inflation-Targeting Emerging Economies." International Monetary Fund Occasional Paper No. 267.

Walsh, C. E. 2009. "Inflation Targeting: What Have We Learned?" *International Finance* 12 (2): 195–233.

Understanding Systemic Risk in the Banking Sector: A MacroFinancial Risk Assessment Framework

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- The recent financial crisis highlighted the need for a better assessment of systemic risk—risk at the level of the entire financial system. Thus, models of the financial system and the complex interactions of the institutions within it have become a major priority for central banks. The development of the MacroFinancial Risk Assessment Framework (MFRAF) is an important step because it provides a framework in which the interconnections between liquidity and solvency in a financial system are modelled, and in which multiple institutions are linked through an interbank network.
- The MFRAF integrates funding liquidity risk as an endogenous outcome of the interactions between solvency risk and the liquidity profiles of banks. This approach is complementary to the new Basel III Liquidity Coverage Ratio framework for Canada.
- The primary goal of the MFRAF is to help measure risks in the Canadian banking system. The calibration exercise presented in this article highlights the vulnerability of leveraged institutions to the combination of low cash holdings and excessive dependence on short-term debt funding, a key feature of the recent global financial crisis.
- The model can also be used as a tool for policy analysis by quantifying the trade-offs among higher capital ratios for banks, increased liquid assets or fewer short-term liabilities in reducing risks in the banking system. Our results illustrate that a regulatory framework that properly controls for systemic risk should consider a bank's capital, holdings of liquid assets and short-term liabilities in a comprehensive manner.

The collective reactions of market participants during the financial crisis of 2007–09 led to mutually reinforcing solvency and liquidity problems at banks around the world. As funding liquidity evaporated, many highly capitalized financial institutions in the United States and Europe had to take significant writedowns on illiquid assets or sell them at a loss, creating uncertainty among market participants about their solvency.[1] Many institutions avoided

1 During periods of financial stress, such as the recent subprime crisis, problems with market liquidity (i.e., when there is difficulty selling assets) and funding conditions can also be mutually reinforcing, leading to downward spirals that make it difficult for banks to maintain adequate levels of liquidity. This reduced liquidity was triggered by concerns about the quality of capital at many of these highly capitalized institutions. See Gauthier and Tomura (2011).

bankruptcy only through massive public intervention. The extent of the support required in response to the crisis illustrated the need to review our approaches to monitoring and regulating the financial system. In particular, liquidity and solvency are often treated as two quite separate dimensions; however, the experience of the crisis is a reminder that they are intertwined. A framework in which these interconnections are modelled is necessary.

Models of the complex interactions among institutions within the financial system are at an early stage of development, but have become a major priority for central banks and other agencies responsible for monitoring systemic risk. This article presents the MacroFinancial Risk Assessment Framework (MFRAF), which is being developed at the Bank of Canada. The MFRAF belongs to a class of macro stress-testing models that are used to sharpen analysis of the principal vulnerabilities in national banking sectors.[2] The MFRAF goes beyond most macro stress-testing models by incorporating the impact of funding liquidity risk, credit risk and the spillover effects of interbank exposures.[3]

The MFRAF goes beyond most macro stress-testing models by incorporating the impact of funding liquidity risk, credit risk and the spillover effects of interbank exposures

We are aware of only one other macro stress-testing model (Aikman et al. 2009) that provides such a comprehensive approach to modelling funding liquidity risk.[4] It uses exogenous rules to impose funding constraints once the balance sheets of banks deteriorate beyond certain predetermined thresholds. The MFRAF has been constructed to provide stronger analytical underpinnings for the links among solvency risk, market liquidity risk and funding liquidity risk, rather than relying on exogenous thresholds.[5] This approach is consistent with the events of the recent financial crisis: a bank's creditors refused to roll over their short-term claims if they had serious concerns about its future solvency. The introduction of such strong microeconomic foundations constitutes a major innovation in macro stress-testing models.

To demonstrate how the model works, and highlight the vulnerability of leveraged institutions to the combination of low cash holdings and excessive short-term debt, we first assess risks in a generic banking system in which the leverage and liquidity profiles of banks are similar to those of the banks that were bailed out during the financial crisis.[6] We then show how the model can be used as a tool for policy analysis by quantifying the trade-offs among higher bank capital ratios, increased liquid assets or fewer short-term liabilities that are required to reduce risks in the banking system. Other potential policy applications include helping to gauge the impact of central bank liquidity facilities during crisis periods or determining the relative contributions of individual banks to systemic risk.[7]

In this article, we first describe the structure of the MFRAF and then present the results from two applications of the framework. In our conclusion, we highlight areas where the framework could be extended.

2 Macro stress testing is conducted simultaneously at many banks, using the same scenario and assessment methodology, which allows for a comparison of results (Foglia 2009). It complements the bottom-up risk assessment that is the cornerstone of most risk management frameworks at major banks.

3 Funding liquidity risk is the risk of loss arising from an inability to roll over existing funding or obtain new funding without incurring a large cost. Credit risk is the risk of loss stemming from a borrower's failure to repay a loan or otherwise meet a contractual obligation. Spillover effects occur when a bank with a serious capital shortfall is unable to fulfill its obligations toward other banks, causing counterparty credit losses that can lead to their potential default.

4 Other studies focusing on the measurement of systemic risk include Huang, Zhou and Zhu (2010) and Gauthier, Lehar and Souissi (2012).

5 Solvency risk, also known as bankruptcy risk, is the risk that a firm will be unable to repay its debts.

6 Leverage is defined as the ratio of total assets to capital.

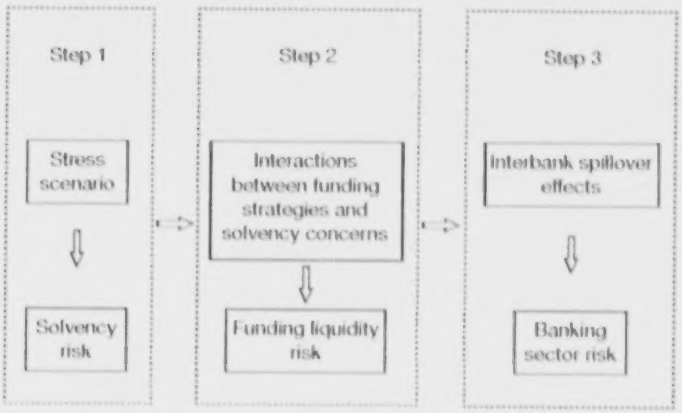
7 Gauthier et al. (forthcoming) use the MFRAF to identify the determinants of systemic importance in various hypothetical banking systems. Another approach to measuring systemic importance is based on market data, as described in Gravelle and Li (2011).

How the MFRAF Works

Drawing on data from bank balance sheets, the MFRAF takes into account solvency risk, reflecting potential losses associated with bank assets (such as credit risk) and funding liquidity risk, as well as network interactions among banks. Figure 1 illustrates the basic structure of the framework, tracing the steps from the macroeconomic shock of the stress scenario to banking sector risk.

The framework involves a three-step process. First, banks are subjected to common adverse macroeconomic shocks that provoke asset losses over a one-year horizon.[8] These losses are due to the decline in the credit quality of the banks' loans, since expected defaults increase as macroeconomic conditions deteriorate. The second step introduces funding liquidity risk. As initial losses reduce bank capital, concerns about the future solvency of the banks mount, causing short-term lenders to refrain from rolling over their claims and thus generating an increase in funding liquidity risk. In the third step, failure or distress at one bank—due to solvency risk or funding liquidity problems—can spill over to other banks through interbank exposures. We will now describe each step in more detail.

Figure 1: **Basic structure of the MacroFinancial Risk Assessment Framework**



Step 1: Solvency risk

In Step 1, the asset losses at individual banks stem from exposures to non bank borrowers.[9] A key input in estimating future loan losses is the default rates in different sectors of the economy. To estimate default rates in the business sector, we use an updated version of the empirical model originally developed by Misina and Tessier (2007). We also use the model described in Djoudad (2009) to estimate default rates on loans within the household

8 An obvious criticism of this approach is that the 2007–09 crisis was triggered by a financial shock generated by losses on subprime loans. This shock was amplified into a banking crisis and eventually a recession (and not the reverse). The framework can accommodate any type of initial shock, however, as long as the impact of that shock is mapped into an impact on bank capital.

9 Work is under way to map the process from initial shock to losses resulting from interest rate risk and market risk. The yield-curve model developed by Yang (2008) can be used to assess the extent of interest rate risk in the loan portfolios of banks, depending on the macro scenario.

sector. Within this framework, structural differences across banks, based on their balance sheets, are taken into account, since the larger a bank's exposure to stressed sectors, the larger its credit loss would be.

Step 2: Funding liquidity risk

The MFRAF introduces funding liquidity risk by adapting recent theoretical advances proposed by Morris and Shin (2009), who note that solvency risk and liquidity risk are intertwined. This observation is consistent with the experience of the recent financial crisis.

The MFRAF divides the one-year horizon into three periods: the beginning of the year, when only expected first-round losses are known; the interim period, six months after the start, when some loan losses are realized, which could lead to a run on the bank by wholesale funding markets; and the end of the year, when total credit losses are observed.[10]

Funding liquidity risk materializes during the interim period, when the bank's short-term creditors have observed any credit losses incurred, are aware of the distribution of losses likely to occur in the next six months, and must decide whether or not to roll over their claims.[11] This decision also depends on their assumptions regarding the proportion of rollovers by other short-term creditors. The more pessimistic the short-term creditors are (i.e., the larger the share of creditors they expect to withdraw), the higher the likelihood of a run on an individual bank. These assumptions are influenced by the bank's ability to use its capital to absorb realized and expected credit losses, its funding structure, and the liquidity of its assets. Better-capitalized banks will be less prone to runs, and banks with lower reliance on wholesale short-term funding markets will be less vulnerable to changes in market sentiment. Moreover, runs become less likely if the bank holds a high level of liquid assets, which are the first defence against funding withdrawal. Market liquidity also plays an important role in creditors' decisions to renew their loans. If banks lack sufficient liquid assets to cover their funding needs and are forced to sell illiquid assets, they will be even more vulnerable to rollover risks, as the expected discount on these assets increases.

This approach to modelling funding liquidity risk in the banking sector is complementary to Basel III's new Liquidity Coverage Ratio (LCR) framework for Canada. While the LCR was designed using exogenous assumptions for withdrawal rates (on short-term liabilities) and drawdowns (on credit lines), the MFRAF assesses the endogenous likelihood of a run on each bank, consistent with market perceptions of the health of that bank.[12]

10 A run occurs when a bank's short-term creditors attempt to withdraw their claims simultaneously (or decide not to roll over their credit at maturity, as they would under normal circumstances) and the bank's liquid holdings are not sufficient to cover the withdrawals (i.e., the institution becomes illiquid). The time frame of the model can be changed by moving the interim date toward the beginning (end) of the scenario. This can have a significant impact on the results, since the amount of funding liabilities to be rolled over at the interim date decreases (increases), and so does funding liquidity risk. See Gauthier, He and Soussi (2010).

11 The greater the uncertainty around potential losses is, the larger the likelihood of a run by short-term creditors.

12 To reduce liquidity risk as well as solvency risk, Basel III will supplement the capital standards with the LCR, which aims to make banks more resilient to the risks associated with short-term funding. See BCBS (2010) for more details.

Step 3: Banking sector risk

The MFRAF incorporates network externalities caused by defaults by counterparties.[13] A defaulting bank (or a bank with a serious capital shortfall) will not be able to fulfill its obligations in the interbank market, causing counterparty credit losses in the system and leading to the potential default of other banks. The size of a counterparty's interbank exposures, as well as factors that heighten insolvency and funding liquidity risk, increase the likelihood of spillover effects generated by counterparty defaults.

Table 1 summarizes the impact (positive or negative) of increases in the degree of various factors affecting the size of interbank spillover effects, as well as the extent of solvency risk and funding liquidity risk. A higher level of capital, for example, would decrease solvency risk, while less reliance on short-term funding would reduce funding liquidity risk.

Table 1: **Impact of an increase in the intensity of key factors affecting risks considered in the MFRAF**

	Solvency risk	Funding liquidity risk	Interbank spillover risk	Banking sector risk
Macroeconomic shocks	+	+	+	+
Reliance on short-term funding		+	+	+
Discount on illiquid assets		+	+	+
Size of interbank exposures			+	+
Holdings of liquid assets		–	–	–
Capital	–	–	–	–

Note: The + (–) sign represents an increase (decrease) in risk.

Applications of the Framework

In this section, we present two different applications of the MFRAF. We first assess the risks in a hypothetical banking system affected by a macroeconomic stress scenario, and then demonstrate how the framework can be used as a tool for policy analysis.

Application 1: Funding liquidity risk and network spillover effects

Canadian banks have been recognized for their resilience during the 2007–09 financial crisis because of lower leverage and lower reliance on wholesale short-term funding markets relative to many of their global peers. In our first application of the model, we illustrate how the Canadian banking system could have been affected had Canadian banks been more leveraged and hence more vulnerable to a liquidity shortfall. We create a hypothetical banking system consisting of six major banks whose main balance-sheet parameters (capital ratio level, reliance on short-term funding and holdings of liquid assets) are in line with those observed in 2007 for banks that were bailed out during the crisis. We calibrate the parameters of each bank as follows: Tier 1 capital ratio at 6 per cent, short-term liabilities (coming to maturity within six months) at 50 per cent of total liabilities and liquid-asset holdings at 10 per cent of total assets. This calibration compares with a 9.5 per cent Tier 1 capital ratio, short-term liabilities at 30 per cent of total liabilities and liquid assets at 12 per cent of total assets, on average, for Canadian banks in late 2007. We set all other balance-sheet parameters at the values for Canadian banks at the second quarter of 2008.

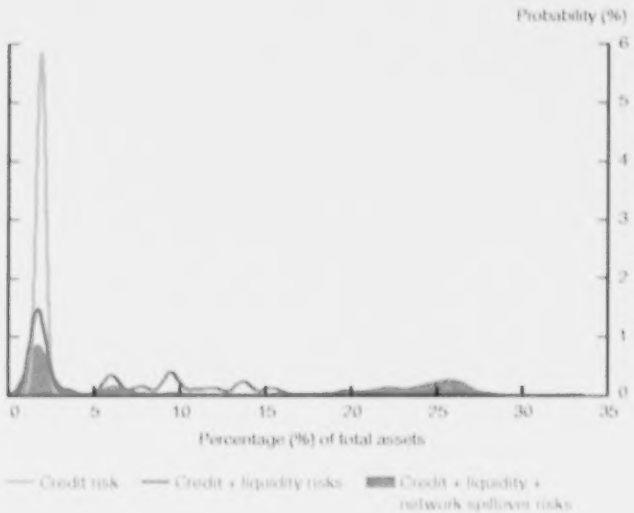
13 An externality is a cost or benefit incurred or enjoyed by a party that was not responsible for the cost or benefit.

Following Gauthier, Lehar and Souissi (2012), we use a severe but plausible macroeconomic scenario with a recession that is about 20 per cent larger than the one experienced in late 2008. The discount on illiquid assets is set at 75 per cent for the average bank.[14] To calibrate the network of exposures among the six banks in the hypothetical banking system, we use actual exposures among the Big Six Canadian banks as of the second quarter of 2008. This includes a set of exposures that exceeds those covered in related literature, which are generally limited to traditional lending, to include interbank exposures arising from cross-shareholdings, as well as exchange-traded and over-the-counter derivatives. The total size of the individual interbank exposures was approximately Can$21.6 billion, or about 25 per cent of individual bank capital, on average.

Chart 1 shows the impact of the various risks analyzed in the MFRAF on the distribution of aggregated losses, as a percentage of total assets, in this hypothetical banking system. When only the direct impact of credit risk is considered (represented by the blue line), maximum system-wide losses are 3 per cent of total assets and average losses amount to less than 2 per cent of total assets. The extreme in the loss distribution (the tail) is, however, significantly affected by adding funding liquidity risk to credit risk (the red line). In this scenario, the negative tail outcomes of potential runs by short-term creditors are much more adverse and more likely to occur. Indeed, when factoring in liquidity risk, the likelihood of the banking system suffering losses larger than 10 per cent of its total assets increases markedly.

The inclusion of interbank network spillover risks on the system-wide loss distribution leads to multiple peaks (the shaded green area). One peak is associated with the average direct outcome of credit losses, while the peak in the right-hand tail captures the combined impact of network spillover

Chart 1: **Loss distributions of a hypothetical banking system for various groups of risks**



Source: Authors' calculations

14 Loans and derivatives are assumed to be totally illiquid, i.e., with a 100 per cent discount.

risks and runs based on liquidity.[15] Our results demonstrate that a failure to account for either liquidity risk or network spillover effects could cause a significant underestimation of the extent of systemic risk in an under-capitalized banking system that relies extensively on the short-term funding market. Both liquidity risk and network externalities are virtually zero when the balance-sheet parameters are set to either the pre-crisis or current values for Canadian banks. Replicating the vulnerability of banks that got into trouble during the crisis, while also showing the robustness of Canadian banks, provides confidence in the ability of the MFRAF to assess risks.

A failure to account for either liquidity risk or network spillover effects could cause a significant underestimation of the extent of systemic risk in an undercapitalized banking system that relies extensively on the short-term funding market

Our results also highlight the importance of obtaining timely information on exposures among banks and suggest that current initiatives under the Basel III framework to promote greater use of central counterparties could be useful in mitigating this risk.

Application 2: Trade-offs between capital and liquidity

As illustrated in Chart 1, for institutions with low capital ratio levels (a 6 per cent capital ratio in this simulation), the presence of liquidity risk amplifies systemic risk. The MFRAF can contribute to the current work to reform liquidity regulation by measuring the trade-offs between higher levels of capital and a more-secure funding structure in reducing systemic risk. To illustrate this, we set the parameters for capital and funding liquidity at the same values for all banks in our hypothetical system. We then let short-term liabilities (S) vary uniformly between 25 per cent and 75 per cent of total liabilities and allow holdings of liquid assets (M) to vary between 5 per cent and 25 per cent of total assets, for two different levels of bank capitalization.[16]

The MFRAF can measure the trade-offs between higher levels of capital and a more-secure funding structure in reducing systemic risk

Chart 2 plots systemic risk—measured as the probability of having at least one bank default—as a function of M and S for capital ratio levels of 6 per cent (a) and 8 per cent (b). As expected, systemic risk generally decreases as the capital ratio increases from 6 per cent to 8 per cent. For a given capital ratio, systemic risk rises as holdings of liquid assets decrease and short-term liabilities increase.

The distributions in Chart 2 (a and b) show the relationship between systemic risk and the two dimensions of liquidity—short-term funding and holdings of liquid assets. In particular, the positive relationship between systemic risk and reliance on short-term funding is much steeper when banks have fewer liquid-asset holdings, for both levels of capital. This means that an illiquid bank is more sensitive to disruptions in short-term funding markets. Similarly, the negative relationship between systemic risk and holdings of liquid assets is more significant when banks have a greater reliance on short-term funding. Consequently, our framework allows us to assess the degree to which an increase in liquid-asset holdings would offset the negative effect on systemic risk arising from increases in short-term liabilities. These results support the new Basel III liquidity standards, demonstrating that both holdings of liquid assets and the structure of funding are relevant for the containment of liquidity risk at individual banks.[17] Limiting liquidity risk would in turn reduce the extent of systemic risk.

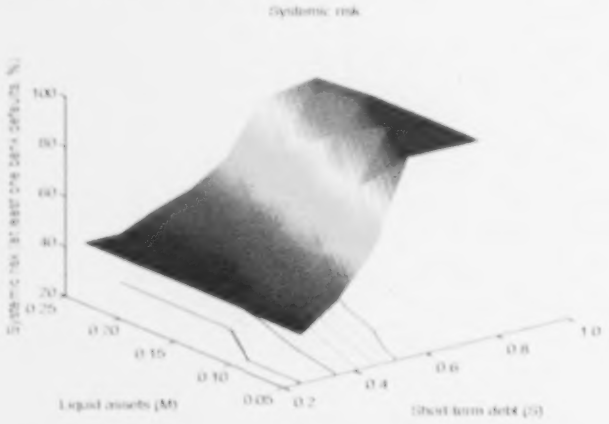
15. Alessandri et al. (2009) also obtain a system loss distribution with multiple peaks that takes into account the effects of network spillover risks and asset-price feedback. When the effects of network spillover risks and liquidity risks are considered, some banks may fail. The multiple modes are driven mainly by calibrated bankruptcy costs.

16. In recent years, Canadian banks, on average, have relied on unsecured short-term funding (holdings of liquid assets) at levels close to the lower (upper) bound of our simulated values.

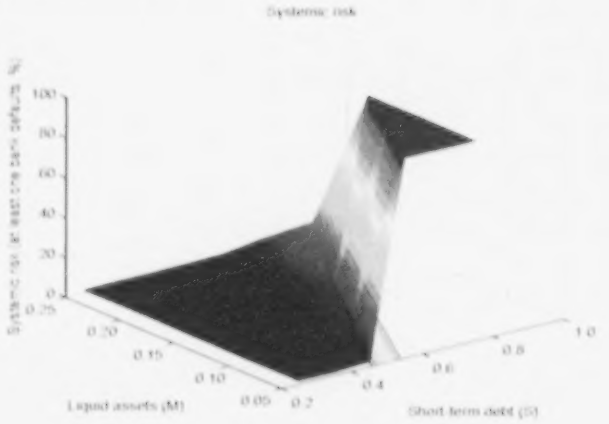
17. For details on the calibration of the LCR, see Gomes and Khan (2011).

Chart 2: Systemic risk for different capital ratios under the assumed severe recession

a. Capital ratio of 6 per cent



b. Capital ratio of 8 per cent



Source: Authors' calculations

Our results also suggest that a regulatory framework that takes systemic risk into account should consider capital, holdings of liquid assets and short-term liabilities in a comprehensive manner. For example, we find that an increase in the capital ratio from 6 per cent to 8 per cent would completely eliminate systemic risk for short-term funding below 40 per cent, and consequently make more liquidity unnecessary. This result is highly sensitive to the assumed capital threshold below which funding problems and network effects occur (zero in this simulation). If these effects were triggered much earlier (for capital close to the minimum requirements, for example), much more capital and liquidity would be required to eliminate systemic risk.

◀ *A regulatory framework that takes systemic risk into account should consider capital, holdings of liquid assets and short-term liabilities in a comprehensive manner*

Concluding Remarks

The MFRAF is a tool for assessing systemic risk in the Canadian banking system. By using it to integrate funding liquidity risk as an endogenous outcome of the interactions among market liquidity risk, solvency risk and the structure of banks' balance sheets, we find that the failure to account for network effects and liquidity risk would cause a significant underestimation of the extent of systemic risk in the financial system.

In its current form, the MFRAF could be used to address various policy questions, such as the impact of central bank interventions on systemic risk during periods of financial stress. Central bank liquidity facilities could reduce the discount on illiquid assets, which would in turn reduce funding liquidity risk and systemic risk. Other potential policy topics include the measurement of the relative cost of regular and contingent capital, and whether bank size is an ideal determinant of a capital surcharge for systemically important financial institutions (see Gauthier et al. forthcoming).

The framework can also be extended in different directions. Work is under way to map the initial shock into losses arising from interest rate risk and market risk, and to introduce the potential for contagion among banks in short-term funding markets owing to, for example, negative information about one of them or about other non-regulated financial institutions.

Another important extension of the model would be to include any negative feedback that could occur between heightened risks to the banking system and the real economy.

Literature Cited

Aikman, D., P. Alessandri, B. Eklund, P. Gai, S. Kapadia, E. Martin, N. Mora, G. Sterne and M. Willison. 2009. "Funding Liquidity Risk in a Quantitative Model of Systemic Stability." Bank of England Working Paper No. 372.

Alessandri, P., P. Gai, S. Kapadia, N. Mora and C. Puhr. 2009. "Towards a Framework for Quantifying Systemic Stability." *International Journal of Central Banking* 5 (3): 47–81.

Basel Committee on Banking Supervision (BCBS). 2010. "Basel III: International Framework for Liquidity Risk Measurement, Standards and Monitoring." Bank for International Settlements. Available at <http://www.bis.org/publ/bcbs188.pdf>.

Djoudad, R. 2009. "Simulations du ratio du service de la dette des consommateurs en utilisant des données micro." Bank of Canada Working Paper No. 2009-18.

Foglia, A. 2009. "Stress Testing Credit Risk: A Survey of Authorities' Approaches." *International Journal of Central Banking* 5 (3): 9–45.

Gauthier, C., T. Gravelle, X. Liu and M. Souissi. "What Matters in Determining Capital Surcharges for Systemically Important Financial Institutions?" In *Simulation in Computational Finance and Economics: Tools and Emerging Applications*. IGI Global (forthcoming).

Gauthier, C., Z. He and M. Souissi. 2010. "Understanding Systemic Risk: The Trade-Offs Between Capital, Short-Term Funding and Liquid Asset Holdings." Bank of Canada Working Paper No. 2010-29.

Gauthier, C., A. Lehar and M. Souissi. 2012. "Macroprudential Capital Requirements and Systemic Risk." *Journal of Financial Intermediation*. Available at <http://dx.doi.org/10.1016/j.jfi.2012.01.005>.

Gauthier, C. and H. Tomura. 2011. "Understanding and Measuring Liquidity Risk: A Selection of Recent Research." *Bank of Canada Review* (Spring): 3–11.

Gomes, T. and N. Khan. 2011. "Strengthening Bank Management of Liquidity Risk: The Basel III Liquidity Standards." Bank of Canada *Financial System Review* (December): 35–42.

Gravelle, T. and F. Li. 2011. "Measuring Systemic Importance of Financial Institutions: An Extreme Value Theory Approach." Bank of Canada Working Paper No. 2011-19.

Huang, X., H. Zhou and H. Zhu. 2010. "Assessing the Systemic Risk of a Heterogeneous Portfolio of Banks During the Recent Financial Crisis." Bank for International Settlements Working Paper No. 296.

Misina, M. and D. Tessier. 2007. "Sectoral Default Rates Under Stress: The Importance of Non-Linearities." Bank of Canada *Financial System Review* (June): 49–54.

Morris, S. and H. S. Shin. 2009. "Illiquidity Component of Credit Risk." Princeton University. Photocopy.

Yang, J. 2008. "Macroeconomic Determinants of the Term Structure of Corporate Spreads." Bank of Canada Working Paper No. 2008-29.

Conference Summary: New Developments in Payments and Settlement

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The Bank of Canada's annual economic conference, held in November 2011, brought together leading researchers from universities, central banks and other institutions from around the world to discuss the issue of New Developments in Payments and Settlement. The conference covered such topics as the use of cash and other means of payment in retail transactions, large-value payments systems, and over-the-counter markets and central counterparties.

Over the past few decades, payment and settlement systems, the backbone of a modern financial system, have undergone major changes. On the retail side, the pace of innovation has picked up markedly, providing consumers with access to new payment instruments such as contactless, mobile and Internet payments. Central banks need to be concerned about the robustness and efficiency of the retail payments system, since it is a key element in a well-functioning economy. In addition, central banks need to be able to assess the effects of innovations in retail payments on the future demand for cash. For large-value payments, safe and efficient interbank settlement systems helped to ensure that financial systems in Canada and elsewhere withstood the turbulence of recent years, and allowed central banks to intervene when necessary. Large-value payments systems worldwide continued to function well during the 2007–09 financial crisis, even in an environment marked by large-scale liquidity problems and the default of major financial institutions. This experience highlights the importance of building robust market infrastructures to ensure financial stability and efficiency.

The Bank of Canada's 2011 economic conference comprised four sessions and included the John Kuszczak Memorial Lecture and a keynote address. The remainder of this article summarizes the papers presented and the discussions that followed.

Session 1: Cash and Means of Payment

As the sole issuers of bank notes, central banks need to understand the reasons for changes in the demand for notes. However, it has been difficult to conduct research on the use of cash, because relevant data have not been readily available. Researchers, especially those in central banks, have recently begun to conduct surveys to collect data on the use of different retail payment instruments. These surveys help researchers to carry out

empirical studies on the use of cash and other means of payment and allow those who model the demand for cash or the choice of payment method to test the implications of their models.

In their paper "The Demand for Liquid Assets with Uncertain Lumpy Expenditures," **Fernando Alvarez** (University of Chicago) and **Francesco Lippi** (University of Sassari and the Einaudi Institute for Economics and Finance, in Italy) study the implications of large and uncertain purchases for liquidity management in inventory models. In their model, an agent has to pay in cash for consumption, which consists of two components: one that is small and occurs with certainty, and one that is large and occurs with a positive probability (a lumpy purchase). The agent has to decide on the optimal amount and frequency of cash withdrawals because withdrawing cash entails an adjustment cost and keeping cash on hand entails a holding cost. The addition of lumpy purchases significantly complicates the mathematical analysis of the resulting inventory model and the characterization of the optimal inventory policy.

One strategy for the agent is to withdraw and hold enough cash to cover both purchases. The authors show that, as the size of the lumpy purchase increases and its probability of occurrence decreases, the agent will make additional cash withdrawals to cover the lumpy purchase only when it occurs. In this case, the lumpy purchase has no effect on the average cash holdings, but it does affect the average size of withdrawals. The model results are then tested with a data set based on a survey diary of the cash-management practices of Austrian households, as well as a data set based on panel information on the management of liquid assets by Italian investors. The authors find that their model can explain some empirical regularities, for example, the frequency and size of cash withdrawals relative to average cash holdings, better than traditional models.

David Andolfatto (Federal Reserve Bank of St. Louis and Simon Fraser University) found the work to be an impressive technical achievement. Although the authors focus on understanding a particular detail in the cash-management practices of households, he noted that this work could be important because the welfare implications of changes in monetary policy can frequently hinge on the details of the underlying microstructure of the model. **Brian Peterson** (Bank of Canada) noted that lumpy purchases often underpin cyclical movements of the economy and are likely sensitive to fluctuations in interest rates. As such, financial innovation and nominal interest rates would influence how lumpy purchases affect the demand for money and the transmission of monetary policy. On one hand, financial innovation that reduces the cost of withdrawing cash could eliminate these effects. On the other hand, decreasing nominal interest rates cause banks to move to a fee-based system, so that lumpy purchases may affect the demand for money once again. In this situation, policy-makers may need to re-evaluate the importance of the demand for money in formulating monetary policy.

In their paper "How Do You Pay? The Role of Incentives at the Point of Sale," **Carlos Arango**, **Kim Huynh** and **Leonard Sabetti** (Bank of Canada) use discrete-choice models and a survey data set of Canadian households to study the choice of using cash, debit cards or credit cards at the point of sale. The Bank conducted the survey in 2009 to develop a microdata set for empirical research on payment choices in Canada. Adult Canadians were asked to complete a survey questionnaire and keep a three-day shopping diary of personal transactions. The results of the study suggest that payment choices are a function of the attributes of different payment

instruments, such as fees, rewards, interest rates, speed and security. For example, because of its ease of use, cash is used predominantly for transactions below $25. There is also a strong tendency to substitute credit cards for debit cards for transactions above $25 because of the rewards programs associated with credit cards. The effect of rewards on the use of cash, however, is relatively small. Finally, debit cards are most commonly used by consumers who do not have to pay fees for each transaction. Overall, however, consumers prefer cash because it is easy to use and widely accepted.

Joanna Stavins (Federal Reserve Bank of Boston) noted that the Canadian survey results are quite similar to those from a survey of U.S. households conducted by the Federal Reserve Bank of Boston. Compared with Canadian households, however, a greater number of U.S. households carry a balance on their credit cards. Moreover, U.S. households are charged smaller fees for their credit cards and lower interest rates for carrying a balance on the card. **Victor Aguirregabiria** (University of Toronto) suggested that identifying supply factors might be useful, if information on merchants' acceptance of various means of payment at the transaction level is available, since that would make it easier to separate demand and supply factors in the choice of means of payment. He also noted a potential endogeneity problem, since consumers might choose merchants based on whether they accept their preferred method of payment.

Session 2: Credit and Means of Payment

Recent policy debates on regulating the retail payments system are motivated in part by concerns about the welfare implications of different payment instruments. In their paper "On the Welfare Effects of Credit Arrangements," **Jonathan Chiu, Mei Dong** and **Enchuan Shao** (Bank of Canada) examine the effects on social welfare of using credit as a means of payment. They construct an economic model in which users of cash face a liquidity constraint because their consumption is limited to their holdings of cash. In this model, the availability of credit arrangements can generate two opposite effects on welfare. The access to credit relaxes liquidity constraints and, as a result, agents can consume more. In this case, the use of credit can generate a private gain to those who have access to it. However, higher consumption among credit users can also generate a negative externality. Specifically, increased consumption will drive up market prices, tightening the liquidity constraints on those who do not have access to credit, thereby reducing their consumption. Thus, the net social welfare consequence depends on the relative strengths of these two effects. The authors derive conditions under which using credit can be welfare reducing, and illustrate how this inefficiency can be corrected by charging different prices to cash and credit users, for example, by providing a discount to cash users or surcharging credit users.

William Roberds (Federal Reserve Bank of Atlanta) noted that monetary theory appears to suggest that using credit cards to make payments is welfare improving. In real life, however, using credit cards as a means of payment involves fees and monopolistic behaviour. He also pointed out that the model's result—that cash users receive a discount—is at odds with reality, since credit card users may actually pay less because of the rewards attached to the cards. **Charles Kahn** (University of Illinois at Urbana-Champaign) argued that welfare comparisons based on holding steady-state monetary policy constant are problematic because the central bank

cannot react optimally to the change in the demand for money caused by the introduction of credit. He suggested that this issue may account for the paper's counterintuitive result that credit is welfare reducing.

In their paper "Why Do Banks Reward Their Customers to Use Their Credit Cards?" **Sumit Agarwal** (Federal Reserve Bank of Chicago), **Sujit Chakravorti** (The Clearing House) and **Anna Lunn** (Federal Reserve Bank of Chicago) use a data set from a large national U.S. financial institution to study the effects of rewards and lower interest rates on credit card spending and debt. The data set contains a representative sample of about 12,000 credit card accounts from June 2000 to June 2002. It includes monthly information from account statements on credit card spending, repayment, balance, debt, interest rate and credit limit. The authors estimate the impact of a 1 per cent cash-back reward on the payment behaviour of consumers before and after enrolment in the program. The results suggest that, while the offer of cash-back rewards increases spending and debt on that particular credit card, the overall balance held across all credit cards does not change. This implies that consumers switch their debt to cards that provide rewards, as well as use them for spending. The authors conclude that cash-back rewards are an effective tool for issuers to increase consumer spending on a specific card and to lure customers away from competitors.

Nadia Massoud (York University) noted that it is also important to examine the switch from other methods of payment to credit cards offering rewards and to perform more robustness tests. **Ben Tomlin** (Bank of Canada) noted that even a small monetary incentive could affect a consumer's choice of credit card. He also wondered whether the results are economically significant and whether the rewards program is profitable for the financial institution offering it.

John Kuszczak Memorial Lecture

In his lecture "The Changing Payments Landscape," **Richard Schmalensee** (Massachusetts Institute of Technology) discussed the challenges and issues raised by the recent dramatic increase in the pace of innovation related to payments. Key factors driving the innovations in retail payments include the introduction of new technologies such as smart phones and open, cloud-based software platforms, as well as new business models based on potential profits from the merging of data sets to enhance marketing capabilities. Since payments systems are multi-sided platforms that facilitate interactions between members of different groups such as consumers and merchants, the success of a new system depends on its adoption by all user groups. Despite a number of promising and exciting innovations in retail payments systems, many of them have failed because they were not adopted by all participants.

Schmalensee pointed out that these developments have raised a number of regulatory concerns related to such issues as competition, interchange fees and consumer protection. Some countries have regulated interchange fees and pricing. Such regulations, however, may affect payment choices and inhibit the entry of new payments systems. He suggested that although the introduction of new technology-based devices is continuing, compelling technology alone does not address the challenges of establishing a successful payments platform, since consumers will have to adopt the innovative product. Merchants will be the key to successful payments innovations,

because they need to pay for the installation of new payments terminals. While it remains to be seen which new retail payments technologies will be adopted, Schmalensee noted that all of these developments will reduce the use of cash.

Session 3: Large-Value Payments Systems

In the wake of the global financial crisis, the private sector, governments, regulatory agencies and central bankers are moving to address the vulnerabilities that were exposed in the financial system. Efficient and resilient payment and settlement systems are critical to building a more-robust financial system. For large-value payments, liquidity in the financial system is essential to facilitate the settlement of transactions, including those related to activities involving the transformation of assets and maturities that support the efficient allocation of resources. Moreover, policy-makers need to ensure that these payment and settlement systems are resilient to operational risk and default.

In their paper "Settlement Liquidity and Monetary Policy Implementation: Lessons from the Financial Crisis," **Morten Bech**, **Antoine Martin** and **James McAndrews** (Federal Reserve Bank of New York) review the liquidity of the payments activity on the Fedwire Funds Service (the primary U.S. network for large-value or time-critical domestic and international payments) during the financial crisis of 2007–09. The authors find that settlement liquidity, measured by the time of day that payments were sent (with payments made earlier in the day suggesting fewer delays), increased during the financial crisis. This was because reserve balances increased substantially, since participants wanted to hold their cash in a safe place, and the Federal Reserve purchased and reinvested US$1.725 trillion in securities, crediting reserve accounts. Data analysis shows that this increase appears to be highly correlated with a remarkable acceleration in the rate of payments settled on the Fedwire Funds Service, leading to a much higher level of settlement liquidity in the U.S. payments system.

The authors conclude that the provision of high levels of reserves can significantly improve the functioning of payments systems. They also consider implications for monetary policy operations. First, with respect to the efficiency of the payments system, monetary authorities should reduce the opportunity cost of the marginal level of reserve balances. Second, monetary authorities should balance the benefits of allocating higher reserves for the efficiency of the payments system with the increased interest rate risk associated with larger holdings of assets.

Julio J. Rotemberg (Harvard Business School) suggested that, in examining this issue, it is important to understand why the market for intraday immediacy of settlement may not work well, and to know the costs of the delays in settlements. Banks currently have discretion on when to submit customer requests to a large-value payments system. Rotemberg questioned whether it would be more efficient if all customers posted their requests directly to a central system that eliminates cycles.

David Longworth (Queen's University, Carleton University and former Deputy Governor of the Bank of Canada) compared the experiences of institutions in the U.S. and Canadian payments systems, noting that "any measure of settlement liquidity that also takes behaviour into account is likely to be . . . system-specific." He also discussed certain implications for

researchers and policy-makers in Canada. First, he said, it would be useful to undertake decile-based research on the time of payments in Canada to deepen our understanding of the policy effects on the Large Value Transfer System (LVTS). Second, policy-makers should examine both the micro and macro effects of providing large settlement balances, and reconsider whether it is appropriate to reduce settlement balances in the LVTS to as low as possible in normal times to minimize the cost to direct clearers and the size of the Bank of Canada's balance sheet.

Given the increasing linkages among many payments systems, potential spillovers across systems are an important policy concern. In "Information Asymmetries and Spillover Risk in Settlement Systems," **Elizabeth Foote** (London School of Economics and Political Science) constructs a game-theoretical model to study spillovers when potential problems in a system remain private information among its participating banks. She argues that, in a world where two payments systems are linked by a dual-system bank, the bank may withhold information about a potential problem in one system, causing the problem to be transmitted to the other system. She suggests that the solution to the problem of spillover risk is better dissemination of information or the adoption of liquidity-saving mechanisms.

Stephen Williamson (Washington University in St. Louis) suggested that Foote's model should be more explicit about important features of payments systems, such as asset prices, central banking and central bank intervention, the role of collateral, the balance sheets of banks, and the descriptions of actual payments, since these features may have important implications for the risk of spillovers. **Rodney Garratt** (University of California, Santa Barbara) suggested improving the model by endogenizing the initial liquidity choices of banks. He also suggested that the author clarify the model's relevance to systems with priced credit (such as Fedwire since 2011) and to the new regulations on double counting issued by the Financial Services Authority and the Bank of England.

Session 4: Over-the-Counter Markets and Central Counterparties

During the recent financial crisis, the opacity and interconnectedness of the derivatives markets amplified and transmitted financial shocks. To address this vulnerability, leaders of the G-20 countries have mandated central clearing for all standardized over-the-counter (OTC) derivatives to help control systemic risk. Through novation, risk mutualization and orderly close-out procedures, central clearing with proper risk controls can reduce the knock-on effects and contagion risks within systems in times of stress, thus dampening private liquidity cycles. The central clearing system must be carefully designed to ensure appropriate risk-proofing, while sidestepping unintended consequences.

In the paper "Emergence and Fragility of Repo Markets," **Hajime Tomura** (Bank of Canada) presents a framework where cash investors and dealers participate in an OTC bond market. In the model, bilateral OTC trade leads to an endogenous bond-liquidation cost for cash investors. This cost induces dealers and cash investors to enter into repo transactions, and also discourages cash investors from entering into repos in a repo-market collapse. Thus, it helps to explain both the emergence and the fragility of repo markets. The author describes policy experiments demonstrating that a

central bank loan facility for dealers, such as the Federal Reserve's Primary Dealer Credit Facility, or a central counterparty (CCP) could prevent the collapse of repo markets.

Christine Parlour (University of California, Berkeley) pointed out that the paper's policy implications suggest that regulators should try to enforce anonymity through the use of intermediaries such as asset managers. She also suggested that the model could be extended to incorporate differences in tri-party repo markets,[1] for example, by adding clearing banks. **David Skeie** (Federal Reserve Bank of New York) suggested empirically testing the model's counterintuitive result that liquidity in spot bond markets leads to the fragility of repo markets.

Keynote Address

In his keynote address, "Replumbing the Financial System: Uneven Progress," **Darrell Duffie** (Stanford University) offered a critique of the measures taken by central banks and regulatory agencies following the recent financial crisis to ensure the financial system's ability to transfer risk and provide credit. He highlighted the difficult trade-offs involved in ensuring that three key areas of the financial system's "plumbing"—clearing banks in tri-party repo markets, prime brokers and clearing houses for trading derivatives—function effectively, even under stressful market conditions.

Regulatory changes that decrease the time between settlements of the two sides and the administrator of a tri-party repo contract reduce, but do not eliminate, the credit risk faced by the clearing house. As well, these regulatory changes do not address agency problems between clearing houses and dealers. Duffie argued that solutions to these problems might be achieved by centralizing the provision of repo services, although such a solution could lead to the service provider becoming "too big to fail."

Duffie also pointed out that regulation in the United States that limits the use by prime brokers of securities pledged by hedge funds as sources of funding did not prevent runs arising from a loss of confidence in the brokers' solvency. While such runs could be prevented by "ring-fencing" the securities deposited by the hedge funds in a custodian's account, this would raise the cost of prime brokerage services.

Drawing on his research with Haoxiang Zhu, Duffie noted that regulations on centralized clearing could increase total margin requirements when margin calculation based on global netting of positions is not feasible because of contracts with multiple CCPs. He concluded by citing work undertaken by a study group of the Committee on the Global Financial System of the Bank for International Settlements, which details the supervisory and efficiency trade-offs involved in the various CCP configurations.[2]

1 At the centre of the U.S. repo market sits the tri-party model, where a custodian bank, either the Bank of New York Mellon or J.P. Morgan, helps to administer a repo agreement between two parties. An investor places its money with the custodian bank, which in turn lends it to another institution. Assets are then pledged as collateral for the loan.

2 See "The Macrofinancial Implications of Alternative Configurations for Access to Central Counterparties in OTC Derivatives Markets," CGFS Papers No. 46, Bank for International Settlements, 2011.

List of Conference Papers[3]

Agarwal, S., S. Chakravorti and A. Lunn. 2011. "Why Do Banks Reward Their Customers to Use Their Credit Cards?"

Alvarez, F. and F. Lippi. 2011. "The Demand for Liquid Assets with Uncertain Lumpy Expenditures."

Arango, C., K. P. Huynh and L. M. Sabetti. 2011. "How Do You Pay? The Role of Incentives at the Point of Sale."

Bech, M., A. Martin and J. McAndrews. 2011. "Settlement Liquidity and Monetary Policy Implementation: Lessons from the Financial Crisis."

Chiu J., M. Dong and E. Shao. 2011. "On the Welfare Effects of Credit Arrangements."

Foote, E. 2011. "Information Asymmetries and Spillover Risk in Settlement Systems."

Tomura, H. 2011. "Emergence and Fragility of Repo Markets."

3 The slides of the presentations discussed in this article are available on the Bank's website at <http://www.bankofcanada.ca/publications-research/research/conferences-seminars-and-workshops/new-developments-payments-settlement-conference-17-18-nov-2011/>.